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MOTHER-OF-PEARL AND ITS SOURCES.

By R. Lydekker.

OF the various descriptions of shells employed in European manufactures and arts, by far the most important position is held by those yielding the beautiful substance known as mother-of-pearl, so largely used for buttons, knife-handles, inlaying, etc. Forming the inner or "nacreous" layer of the shells of many kinds of molluscs, mother-of-pearl is characterized by its more or less marked iridescent play of colours and its "pearly" nature, being, in fact, in all respects identical in substance with pearls themselves. Unlike the colouring of the outer surfaces of shells, which is due to the deposition of pigment in their substance, the iridescence of mother-of-pearl is caused by the mechanical arrangement of the particles of the shell itself, which form a number of extremely minute and delicate ridges and grooves, thus breaking up the light falling upon them into its constituent elements. Pearly lustre is, indeed, precisely analogous to the colours of thin plates or films, and that it is really due solely to mechanical structure is rendered evident by the fact that impressions taken from mother-of-pearl in gum or fusible metal exhibit the same play of colours.

Although the shells of several kinds of molluscs are employed as sources of mother-of-pearl, those of the pearl-oyster form the staple of the trade. This is due to the fact that in no other shell does the pearly substance form such a thick and flat layer as it does in the pearl-oyster of commerce. As regards intensity and variety in the play of colours, the mother-of-pearl of the pearl-oyster is, in reality, much inferior to that yielded by the ear-shells (mentioned in the sequel); but for intrinsic beauty the former is perhaps unrivalled. Strictly speaking, the commercial pearl-oyster is not an oyster at all—that is to say, it is not included in the same family with the edible oyster. It belongs, however, to the same group of bivalve molluscs as the latter—the true oysters (*Ostreidæ*), scallops (*Pectinidæ*), thorny oysters (*Spondylidæ*), file-shells (*Limidæ*), and pearl-oysters and their allies (*Aviculidæ*) forming a closely-related assemblage of families. In all the members of this group the gills are folded, the edges of the two flaps of the mantle are quite distinct from one another, and the foot is comparatively small, or even rudimentary. The *Aviculidæ*, or pearl-oyster family, presents the following distinctive features:—The two valves of the shell are more or less unequal, and the vertical or central axis of each is placed very obliquely to the practically toothless and straight hinge-line, the extremities of which are often produced into long wing-like processes. Accordingly, the whole shell is very unsymmetrical, and the attachment of the two valves is formed entirely by the horny ligament. Externally, the shells are more or less rough and scaly, with the annual lines of growth marked by concentric ridges, while internally they are smooth and pearly. A notch beneath the anterior wing marks the position of the byssus, or mooring-rope, secreted by the small foot. In the more typical members of the family, or those properly belonging to the genus *Avicula*, the shell is comparatively thin, and the wings of the hinge-line, especially the hinder one, are very long and slender. On the other hand, in the true pearl-oysters, the shell often becomes much thickened, and the wings, with the exception of a rudiment of the anterior one, are not developed. Unfortunately, there is a difference of opinion among naturalists how much importance should be attached to these points of distinction, and we consequently find the true pearl-oysters sometimes described as *Avicula*, and at others as a distinct genus—*Meleagrina*. It is a matter of comparatively little importance which course is adopted, and they will here be alluded to under the latter title, as being the one in most general use.

Of pearl-oysters there are two distinct types. One is represented by the Ceylon pearl-oyster (*Meleagrina fucata*), in which the shell is comparatively small, and so thin as to be reckoned of no value in the mother-of-pearl trade, this species being fished only for the sake of its valuable pearls. The commercial pearl-oyster (*M. margaritifera*) (Fig. 1), which likewise produces pearls, has, on the other hand, a much larger and more massive shell, the two valves of which will not unfrequently weigh as much as two and a half pounds. And it is these shells which yield the great supply of commercial mother-of-pearl.

Pearl-oysters occur in vast banks in many parts of the Indian Ocean, Red Sea, Persian Gulf, and the warmer portions of the South Pacific, generally at about twelve fathoms depth. Formerly they were fished by divers, especially women, who worked without any special apparatus, and brought up a mollusc under each arm; but of late years the diving-dress has come largely into use.

XUM

According to the trade-reports of Messrs. Lewis and Peat,* of Mincing Lane, mother-of-pearl oysters are classified commercially into the following chief descriptions: (1) Australian, (2) black-edged Tahiti, etc., (3) Fiji and Sydney, (4) Egyptian, (5) Bombay, (6) Zanzibar, (7) Manila, (8) Mergui, (9) Banda black-edged, (10) Panama, and (11) Shark's Bay. All these different descriptions can be easily recognised by commercial experts; but, from the mixture of localities and the observations which follow, it is evident that many of them do not indicate distinct local races

Fig. 1.—Inner Surface of One Valve of Commercial Pearl Oyster. One-third natural size.

of the species, although others may probably be regarded as such. All descriptions are further subdivided, according to size, quality and condition, into "bold," "medium," "small medium," "chicken," "pickings," "broken pieces," and "stale and dead," which, in each description, diminish in price from the first two or three to the last. Furthermore, the shells, irrespective of origin, vary in value according as the margin of the interior is pure silvery-white, yellow, as in Manilla and Queensland samples, or black, as in those from Tahiti and Panama; the white, or silver-lipped, being the most, and the smoky, or black-edged, the least valuable, although there is some amount of variation in this respect according to fashion.

Pearl-oysters being sold in London by the hundredweight, it might seem an easy matter to obtain from the trade-reports the amount of the annual imports. Unfortunately this is not the case, since the consignments are reckoned by "packages," so that only the price per hundredweight can be ascertained; but it may be taken as certain that the imports are to be reckoned by hundreds of tons. As regards price, it would appear that, in spite of very heavy fluctuations that have taken place according to supply and demand during the last half-century, at the present day the value is much higher than the former average, and this, too, when the supply, owing to steam communication, may be presumed to be fairly constant. We read, for instance, in the first edition of Woodward's "Mollusca," published in 1851, that the price per hundredweight then ranged from two pounds to four pounds, and that the annual import of silver-lipped shells from the Society Islands to Liverpool was only about four hundred hundredweights, and that of the black-edged from Manila six hundred hundredweights in the year mentioned. Of the smaller Panama shells, however, the average annual import was at that time four thousand hundredweights, and in 1851 a single vessel brought upwards of six thousand eight hundred hundredweights (three hundred and forty tons).

About 1853, from which date till 1870 annual returns were issued by the Board of Trade, the mother-of-pearl imports seem to have received a new impetus, the following being the seven maximum years during that period:—

1856 = 42,032	hundredweights,	valued at	£76,544.
1859 = 40,003	,,	,,	67,859.
1869 = 37,662	,,	,,	94,015.
1854 = 36,644	,,	,,	88,305.
1867 = 36,175	,,	,,	70,426.
1857 = 34,324	,,	,,	57,819.
1868 = 32,002	,,	,,	64,869.

From this it appears that in the last year mentioned the average price was almost exactly two pounds per hundredweight, while in 1869 it was somewhat above, and in 1856 rather below that sum.

Turning now to Messrs. Lewis & Peat's trade-report for January, 1898, a single glance will show the enormous advance on these prices. Among the various descriptions of Australian shell the highest price was obtained for best Australian samples, in which "chicken" yielded eleven pounds twelve shillings and sixpence per hundredweight, "small medium" ten pounds seventeen shillings and sixpence, and "stale and dead" a minimum of three pounds two shillings and sixpence. Of other Australian shell, "Sydney and Queensland" showed a maximum of ten pounds twelve shillings and sixpence for "chicken," and a minimum of two pounds ten shillings for "dead and stale," while the descriptions respectively known as "Colonial sorted" and "Port Darwin" yielded very similar returns. On the other hand, the Australian shell known as "New Guinea character" ranged somewhat lower in value—"bold and medium" realizing eight pounds seventeen shillings and sixpence, and "stale and dead" two pounds. In shell coming under the description of black-edged, the maximum and minimum in "Tahiti" were nine pounds five shillings and three pounds, respectively. Cheaper still was that variety of black-edged described as "Gambia"—the maximum price being five pounds fifteen shillings per hundredweight. Here it should be mentioned that the word "Gambia" would naturally lead the uninitiated to believe that the shells came from the West Coast of Africa, where, so far as we are aware, pearl-oysters are totally unknown. The explanation of the mystery seems to be that "Gambia" is a trade corruption for "Gambier," which is the name for a small group of islands in the Low Archipelago, not very far from Tahiti, where there is an extensive pearl-fishery.

Another, although less glaring, misnomer occurs in the case of the so-called Egyptian shell, which is really obtained from the Red Sea, and was formerly shipped from Alexandria. About 1870 the annual shipment of shell from that port to Liverpool averaged about twelve thousand hundredweights; but some years later it fell to half that amount. The maximum price for this class realized in the January sale, 1898, was six pounds two shillings and sixpence per hundredweight. "Bombay" shell, again, which at the same sale reached a maximum of six pounds twelve shillings and sixpence, instead of being dredged off the city from which it takes its name, really comes from the Persian Gulf. Most of these shells are small, with dark edges; and although they used to realize more than the

* The writer takes this opportunity of expressing his thanks to that firm for much valuable information on this and kindred subjects.

Tahiti black-edged, they are now somewhat cheaper. A large quantity go to Birmingham for manufacture into buttons and counters, as well as for inlaying—the annual imports, some years ago, oscillating between about three thousand and five thousand hundredweights.

Of other descriptions of pearl-oyster, Manila shell, which is fished from the great banks of these molluscs stretching between the Sulu Islands, through the Strait of Macassar, to Basilan, fetches prices not greatly inferior to some of the Australian descriptions; while Mergui shell, from the archipelago of that name near the Tenasserim coast, is somewhat cheaper, realizing from about five pounds to eight pounds per hundredweight. Cheaper still are the Banda, Panama, and Shark's Bay shell; good samples of the former varying from three pounds fifteen shillings to four pounds five shillings, while similar qualities of the latter range between one pound fifteen shillings and two pounds six shillings and sixpence. Panama shells, which are small and black-edged, each valve weighing only about half-a-pound, are obtained from the Margarita, or Pearl Islands, in the Gulf of Panama. Fair to good qualities sell at prices ranging from three pounds to three pounds seven shillings and sixpence per hundredweight, those from the Island of St. Joseph being the best in quality. About 1855 the trade from these islands began to be of importance, the annual import for some years after that date ranging between sixteen thousand and twenty thousand hundredweights.

The foregoing are the chief descriptions of large pearl-oysters employed in the mother-of-pearl trade; and although these constitute the great bulk of the industry, they by no means include all the commercial sources of that material. Among several other kinds of shells, an important position is held by a small species of pearl-oyster apparently indistinguishable from the Ceylon *M. fucata*, and commercially known as "lingah." These shells measure less than three inches in diameter, and each valve averages only about one ounce in weight. The great bulk of the supply comes from the Persian Gulf, but a certain amount is shipped from New Guinea. As it is imported and sold in packages, the weight is not detailed, but as more than twenty thousand packages were offered at a single sale in 1898, the total amount must be considerable. The price of best quality varies from about twenty shillings to thirty-five shillings per hundredweight, according to the supply and demand. It is somewhat curious that this shell should be valued, while the Ceylon pearl-oyster is rejected.

In the "M. O. P." trade the term "mussel" has a signification different from that in ordinary use, being applied to a species of true *Avicula*, or those forms in which the "wings" are conspicuously developed, and the axis of the shell is very oblique. The particular species used is the common *A. heteroptera*: usually the variety in which the development of the hinder wing is comparatively small. "Bold and medium" shells may measure between five and six inches in diameter, whereas "chicken" shell is only between two and three inches. The number of packages offered at one of Messrs. Lewis and Peat's sales generally ranges between one hundred and one thousand, the price per hundredweight varying from two pounds thirteen shillings to three pounds ten shillings, or even four pounds, for the best quality.

In addition to the foregoing, certain kinds of freshwater mussels (*Unionidæ*) are used in the "M. O. P." trade. These are quoted as American sweet-water mussels, and belong to the genera *Paxyodon* and *Mutela*. When polished, they present a pinkish-white surface, with but little pearly lustre. Both the supply and the demand seem to be limited; and no prices were quoted in 1898. Some are worked up entire, while others are cut up. In the United States there is a considerable manufacture of ordinary pearl-buttons from freshwater mussel shells.

Turning to univalve shells, we find numerous quotations of "Japan ear" in the trade-reports. This shell belongs to the same genus (*Haliotis*) as the much smaller ormer, or ear-shell, found at low tide clinging to the rocks of the shores of the Channel Islands, much after the manner of a large flattened limpet. Indeed, the ear-shells are near relatives of the keyhole-limpets (*Fissurellidæ*), both showing one or more perforations in the shell connected with an excretory duct from the mantle. In the *Haliotidæ* these perforations form a curved line near the margin furthest away from the short spire. Internally the whole of the shell consists of a thick pearly layer, exhibiting a beautifully iridescent play of colours. Some of the tropical species measure from eight to ten inches across the shell. Several of these, like the one from the South Seas, have the shell so convex as to be of little or no commercial value; while in others, like the large Californian species, although the shell is flatter, it is spoiled by the great ridges and grooves on its outer surface. The Japan ear-shell of commerce (*Haliotis gigantea*) (Fig. 2), on

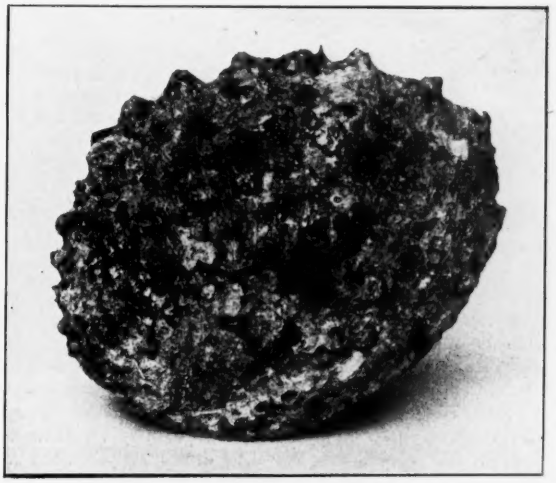

Fig. 2.—Outer surface of "Japan Ear."

the other hand, has a fairly flat and smooth shell, characterised by the large size of the marginal perforations, which are raised into crater-like elevations. As the portion of the shell external to the line of perforations is useless, it is always broken away in commercial specimens. Good samples of Japan ear in this condition realize from about five pounds five shillings to six pounds five shillings per hundredweight; but inferior descriptions sell as low as one pound five shillings. Mother-of-pearl from ear-shells was formerly largely employed at Birmingham for inlaying papier-mâchè ornaments and fancy goods, as it still is in America; but in this country it is now mainly used for studs, buttons, links, buckles, etc., its opalescent green tints rendering it more appreciated for some descriptions than the mother-of-pearl from oysters. Occasionally pounded ear-shell is used to ornament the lettering of shop-fronts. "Abalones" is a commercial name for the mother-of-pearl from ear-shells.

Another shell of some importance in the trade is

known commercially as "green snail," although it really belongs to a marine mollusc of the genus *Turbo*, its full title being *T. olearius*. These shells, which, when polished, display a mixture of green, yellow, and pinkish pearly tints, are of so large a size that they were formerly mounted as goblets for the Scandinavian kings. They are imported from Penang, Manila, and Japan; specimens from the former locality which weigh from one and three-quarter to two and a-quarter pounds selling at from sevenpence to sevenpence farthing each, while small samples varying between one-half and three-quarters of a pound fetch prices from twopence to threepence each. A second and smaller species of the same genus (*T. sarmaticus*), commercially termed "turbo" (Fig. 3), is also employed

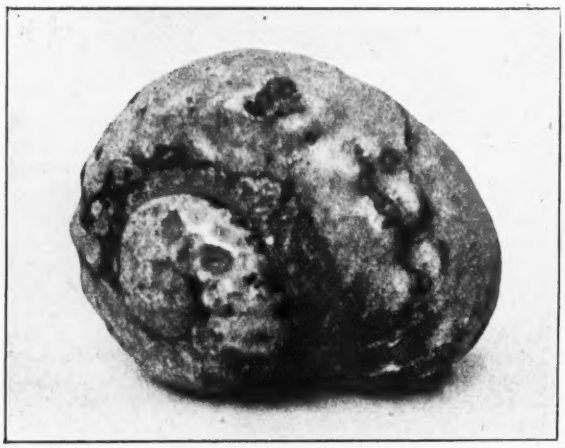

Fig. 3.—The "turbo" of the mother-of-pearl trade.

in the mother-of-pearl trade, although it does not appear to find a very ready sale. Externally this shell is covered with a black epidermis, beneath which the whole structure is pearly, with a greenish tinge. Commercial samples are generally dead shells, more or less coated internally with a calcareous deposit overlying the pearly layer. These shells, which come from West Africa, are cut into sections, and used for small fancy articles, such as baskets, trays, boxes, etc.; but they are also worked up into buttons, brooches, and earrings, while they are occasionally employed as pipe-bowls.

Although seldom quoted in the sales, it may be mentioned that a beautiful little top-shell, *Trochus* (*Elenchus*) *iris*, used, when polished, by the Maories as an ear-drop, is sometimes employed in the mother-of-pearl trade.

This completes the list of shells quoted in English trade circulars as mother-of-pearl producers. Nevertheless, as already said, the full amount and value of the imports at the present day are difficult or impossible to obtain, the figures quoted above afford a fair idea of the great importance of this branch of commerce. In 1878 Mr. P. L. Simmonds estimated the average annual imports at between thirty thousand and forty thousand hundredweights (fifteen hundred to two thousand tons), at an approximate value of one hundred thousand pounds. And if the imports are maintained at anything like that level, present prices would indicate a largely enhanced total value. But to the English trade must be added that of other countries, among which America, Austria, and France figure largely, the latter country being reported in 1878 to work up annually about thirty thousand hundredweights (one thousand five hundred tons) of mother-of-pearl. In 1876 the French imports were given as one million three hundred and seventy-six thousand one hundred and thirty-two kilogrammes, of the value of three million one hundred and fifty-nine thousand nine hundred and forty-three francs; this being apparently exclusive of an annual average import of ear-shells to the extent of one hundred and thirty-four thousand five hundred and fifty kilogrammes.

Some of the uses of mother-of-pearl have been already mentioned, but a few details may be added. Papier-mâché inlaying seems to be a decadent art in this country; nor is this to be regretted, seeing that, from a modern standpoint, it was far from an artistic production. Handles to dessert knives and forks account for a considerable amount of mother-of-pearl, while it is also used to coat card-cases, for fan-handles and the hafts of pocket-knives, as well as for book-covers and countless other fancy articles. Mother-of-pearl, in some instances beautifully carved, was formerly much employed for the tops of snuff-boxes, being sometimes inlaid with tortoiseshell. It is also extensively used by cabinet and piano-makers, and is likewise worked up into boxes, carved brooches and pen-holders. Pearl buttons form a very important item in the trade—the large ones selling at as much as half-a-crown each, while the smaller kinds descend as low as eighteenpence the gross. Whereas in one season pure white may be the fashion for the large buttons, in another the "smoked pearl" of the black-edged oysters or the green pearl of the Japan ear may be solely in demand.

From its extreme density and hardness, the tools suitable for the worker in mother-of-pearl must be of the finest temper, and acids are often employed to aid in its manufacture, while it is polished with calcined iron-sulphate. Chinese and Japanese workmen are adepts in carving this refractory material, and the beauty and finish of some of their work almost, if not completely, defies imitation by the British artizan. In olden days, too, the inhabitants of Polynesia and Melanesia manufactured most beautifully-finished fish-hooks from mother-of-pearl, fine specimens of which are exhibited in the Ethnological Gallery of the British Museum at Bloomsbury. Some of these, from their opalescent green tints, appear to have been cut out of ear-shells, and probably served not only as a weapon to capture fish, but likewise as a bait to lure them to destruction.

ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

III.—Arbitrary Assumptions and Expressions. Scientific Speculation as opposed to Hysteria.

WHEN one is asked, "What is Electricity?" the wisest course of all is to confess ignorance. The sweeping statement of our old friend Democritus certainly holds good here. Many efforts have been made to formulate a scientific definition, and all have been failures. Of these, one of the best I ever heard was a statement to the effect that "Electricity is a particular state of matter." But here there are two unfortunate points—what particular state is not specified, and matter is still, so far as we are concerned, undefined. So that the suggested definition is no definition at all.

Yet electricity is by no means the only science placed in this position, or remaining in it. We do know that certain causes will always produce definable effects. And, when

we are confronted by some specific phenomena we can say without hesitation, "This body is electrified," or "There is a current flowing in this wire." These expressions convey to us very definite meanings, yet they only tell us what we may expect from the body, or wire, under the circumstances. We have no information concerning the first cause. And it may not be too much to assert that this condition of things exists with reference to all natural sciences. Absolutely no moral application is intended here.

We can then easily recognize the presence of electricity, control it, deal with the effects produced by it, reason mathematically concerning it, and design apparatus, or machinery so accurately as to be able to assert, without hesitation, what amount of electrical energy can be obtained from it under given mechanical conditions.

Facing the fact, then, that we can recognise electrical effects but not electricity, we find ourselves compelled to adopt certain arbitrary forms of expression, otherwise we should frequently be at a loss as to how to follow up trains of reasoning and to give utterance to our ideas.

We speak of the flow of the current, yet it is by no means certain that anything does flow. The point is that we require some terse expression; it would not be convenient to say, "From the phenomena observed in the neighbourhood of the wire we know that the wire is in a high state of electrification with reference to the bodies surrounding it." The adoption of the word "flow" has another advantage. In the elementary consideration of current and pressure (both arbitrary expressions) it is of great assistance to regard the conductor which is electrified as being a pipe through which water is flowing, though this analogy must be carefully dealt with, even at first, and ultimately abandoned.

Again, we take it upon ourselves to actually define the direction of the flow, without being aware that there is a flow. But this is done with good reason. In the winding or connecting up of electro-magnets, and in electro-chemical operations, it is almost invariably the essential thing to know beforehand in what direction certain phenomena will occur. In the case of an electro-magnet, if we look at the north-seeking pole, when it actually points to us, we may assert (since we have the useful convention as regards flow) that the current is flowing contra-clockwise round the coil. If there were no other reason for the convention, the convenience here would be sufficient to justify its adoption. We see then that the one assumption that something does flow leads at once to the use of certain arbitrary expressions.

There is another assumption made with reference to the comparison of potentials—*i.e.*, static potentials. One sees the necessity for this by considering that positive and negative potentials are to be spoken of, and since these two expressions are not to be regarded as having their exact mathematical meaning (any more than negative as opposed to affirmative has), it becomes essential that there should be some universally accepted body considered as being without potential. The earth has been chosen, for the obvious reason that it is accessible all the world over, and may be regarded as a good conductor if proper contact be made to it.

Conventions which are based on reasonable and convenient principles, that are well understood, and generally adopted, are just as necessary in scientific as in social circles. But in the former case it is imperative that the fact of their being conventions adopted for the sake of the general convenience must never be lost sight of. For example, when stating that the earth's potential is nought, it must be borne in mind this does not imply that the earth is not an electrified body; any such assertion would be ridiculous, and liable to lead to very grave errors.

The nomenclature of electrical units is based upon an excellent system. Such names as volt, ampère, ohm, joule, farad, and so on, keep before the student the more important branch of some great predecessor's life work, and serve to remind him to what heights human intelligence and industry may attain.

With the rapid growth of electrical undertakings (due to the strides which the science has made) there have not been wanting growths which may be termed parasitical, and growths which may be relegated to the general class termed fungi. This was, perhaps, inevitable, and it must ever be of interest to consider (as dispassionately as may be) the causes which have tended to bring these unpleasant excrescences into existence. Lust of fraudulent gain will in all probability be the dominating influence of a section of the community so long as that community shall last. But of the frauds we would prefer to say little here. Indeed, some suggestions made in the first paper of this series might be considered sufficient, only that reference to a certain wonderful motor was omitted there. This motor crops up frequently; its claim to public attention seems to be based upon two facts, it is reported to get an enormous percentage of its energy from nowhere,* and it seems to have been designed with a view to relieving the public of their superfluous wealth. Alas for the frailty of human nature! The machine in question came into existence at about the time that the first electrical undertaking was "quoted on Change." It is not one month since, reckoning from the actual date of the writing of these lines, that a report was printed in a well-known and high-class paper here of the exposure of an American fraud based upon "The extraction of gold from sea water." It seems that the majority of American frauds find their way over here. To be charitable, we must assume that the little schemes of this nature which have their birth here find their way to America.

But there is another, and a still more widespread source of error. Even in the minds of intelligent men and women there is, as a rule, a deep-rooted love of the marvellous. And this foible is unfortunately pandered to by people who should know better. The result is, all too often, that a section of the community works itself up into a wild frenzy of admiration for some individual whose name becomes a household word. It goes so far at times that the unfortunate recipient of this attention, who may actually have been a really honest worker in the paths of science, is driven into a mental condition which had better perhaps be described as hysterical, and he arrogates to himself the gift of prophecy. It must be trying to the most level-headed of men to find that his name is, in all seriousness, coupled with such titles as wizard, and magician, particularly if the effusions of this sort are circulated throughout the entire world, and in the nineteenth century, by papers of good repute, which in the main employ only responsible contributors.

And there is a case, unique, I think, of a lady novelist who lets her wonderful imagination run amuck in the realms of electrical science, and actually adds, by way of preface, or note, to her remarkable work, that she has the highest scientific authority for the assertions she makes. I have often tried to understand just some little point in connection with the marvels described, but, being only an electrician, have invariably failed.

* Since this was written the inventor of the motor has died. An examination of the building in which the machine was shown has revealed the presence of tubes in its walls. And these tubes conveyed compressed air to the machine.—H. B. L.

XUM

A nation which spends annually enormous sums upon education might well spend an adequate fraction on the suppression of this style of thing.

A certain "Mother Shipton" is credited with the "prophecy" that "one day carriages should run without horses," or something to that effect. Should that Delphic utterance have entitled her, in her own time, to any credit as a discoverer, as an inventor, or as a scientist? Emphatically, no! Yet, not to deprive her of all credit, one may say, without reserve, that she made a shrewd remark.

But there is such a thing as scientific speculation, which may be indulged in with great benefit, both to the actual speculator and those to whom he communicates his ideas. Workers in every branch of science can multiply instances of such rational speculation which have indicated most profitable lines for investigation. In this connection, the chemist might possibly refer to Mendelejeff, the astronomer to Gallileo, and the electrician to Grey or Cromwell Varley.

It will be noted that, so far as electrical workers are concerned, two names are mentioned. Apart from the fact that this is perhaps natural in a paper under the above heading, there is a specific point which I would bring out here. Stephen Grey expressed a hope—to which reference has already been made—while Varley uttered a warning, concerning the speed of signalling which could be attained through a submarine cable. Thus while both indulged in well-founded scientific speculation, and both had the ultimate advancement of science in view, the one encouraged, and the other strove to damp the ardour of his contemporaries.

Many other instances might be quoted, but surely these names will more than serve.

Another form of hysteria, perhaps as pernicious as that already mentioned, has recently led certain really intelligent scientists to announce (with what one can only allude to as a flourish of trumpets) what they are about to do. On the other hand, if it is not they themselves who have made such statements, they have the option of either contradicting them, or stating that they are made without authority. It is in a great measure due to this hysterical tendency that we hear of the internal troubles of scientific societies. A painful controversy is raging now, and the long established constitution of the society appears to be threatened.

But perhaps too much has already been said on this subject. Finally, it may be urged that electricity can add to the foundation of its claim to be an exact science the plain statement that, even when arbitrary assumptions are made and arbitrary expressions are used, a distinctly scientific convention is always adopted, and, the position being so well understood, there is absolutely no danger of serious error being allowed to creep in on account of either such expressions or such assumptions.

As regards scientific speculation which can be justified, electricians can point to their share; but, alas! it must be admitted that we suffer to far too great an extent from hysteria, both internally and externally. The internal suffering is by far the most acute. We can only hope that the external trouble, thrust upon us and the public, is not to be allowed to become chronic.

THE ACETYLENE INDUSTRY.—II.

By George T. Holloway, assoc.r.coll.sc., f.i.c.

It would be impossible within the limits of this article to describe the various generators which have been used or patented for the production of acetylene from calcium carbide, but the general types may be briefly referred to. Those shown at the Exhibition of the Imperial Institute during last summer were divided into three groups—(1) those in which the gas is generated by the action of water dripping or flowing in a small stream upon the carbide; (2) those in which water rises around the carbide; and (3) those in which the carbide falls into water.

In Class 1, the water commonly falls upon the carbide from perforations in a metal pipe, while in Class 2 the water is usually allowed to pass on to or through the carbide, which is contained in perforated trays. This latter arrangement is frequently made automatic, by the carbide being contained in a receptacle fixed to an inner vessel which rises and falls as the gas is generated and used up, as in the case of a gasometer, so that the carbide is raised out of the water or lowered into it, as the gas is produced or consumed. A common form for Class 3 consists of a generator having a side shoot through which the carbide is dropped into the water as required.

A lengthy series of experiments made by Prof. Vivian B. Lewes as to the temperatures developed by the reaction between the carbide and the water under these various conditions, and as to the amount of gas produced, and other matters connected with the application of acetylene, especially for small lighting installations, has resulted in some interesting conclusions. In each of the first two forms there is a considerable liability to such a rise of temperature as leads to polymerization, and also to the partial decomposition of the gas, with production of tar, benzene, and other bodies, which not only reduce the volume of acetylene generated, but also tend to choke up the burner, as described later on. The second class of generator, which constitutes the bulk of those on the market, is found to be less objectionable than the first form, but those of the third class, of which very few are in use, appear to be the most scientific, and give rise to less over-heating, although it has been stated that their yield of gas is below that of the other forms.

After the rapid evolution of gas which occurs on the first admixture of the carbide with water, a slow evolution continues for some time, and for this reason, in apparatus having an automatic "cut-off," the arrangements should be such that the cut-off acts when the gas-holder is not more than three-fourths charged. Finally, a large excess of water must be used to minimize overheating of the carbide, and a cock should be fitted at the base of the generator to draw off the lime sludge formed during the reaction.

The danger of explosion from acetylene gas may be attributed to (1) the action of the acetylene on the metal used in the construction of the gas-holder and its fittings, with production of explosive acetylides; (2) to the presence of phosphoretted and siliciuretted hydrogen and, perhaps, other impurities, and (3) to the endothermic nature of acetylene. Other and unknown causes appear also to form factors in this problem.

The presence of phosphoretted and siliciuretted hydrogen in acetylene is due to impurities in the carbide. Prof. Lewes has found from a trace to 2·3 per cent. of the former gas (an average of 0·65 per cent. on twelve samples) in acetylene, but not more than very small traces of siliciuretted hydrogen were detected, and his experiments tend to show that in carbide of English manufacture there is no danger of explosion from the presence of either of these gases, provided the generator is so constructed as to prevent overheating of the carbide. It appears, however, according to Dr. Grainger, that friction, even such as may be produced by opening a valve, is sufficient in the case of the liquefied gas to sometimes induce an explosion.

Other impurities, such as ammonia, sulphuretted hydrogen, arseniuretted hydrogen, marsh gas, oxygen, nitrogen,

XUM

XUM

CLASSIFICATION OF CLOUDS.

No. 1.—STRATUS.

No. 2.—CUMULO-NIMBUS.

No. 3.—ALTO-CUMULUS.

No. 4.—CIRRUS.

No. 3.—ALTO-CUMULUS.

hydrogen, carbon monoxide, benzene, certain cyanogen compounds and tarry products, are also present, and various methods of washing out the most objectionable of these have been used and proposed, such as bubbling the gas through water, sulphuric acid, calcium chloride solution, and solutions of lead salts.

It is stated that M. Pictet prepares absolutely dry and pure acetylene possessing a distinct, but not unpleasant, odour, having no action on metals, and capable of being compressed without any danger of explosion.

Although it is not impossible that acetylene may be ultimately applicable for heating purposes, it is at present only in use as an illuminating agent, either in its natural state or after admixture with other gases.

Prof. Lewes recommends the use of acetylene mixed to the extent of ten volumes of acetylene with ninety volumes of a mixture of thirty volumes of methane (marsh gas) with seventy of hydrogen, carbon monoxide or water gas. On the Prussian State Railways, a mixture of one volume of acetylene with three volumes of oil gas is in use, and has been found to pass the tests imposed by the Prussian Government. Acetylene has also been used on trains in Ontario and elsewhere with success, and the United States Lighthouse Board propose to employ it for lighting buoys at sea. The danger of explosion already referred to has, however, given rise to various regulations, which much restrict the use of the gas. The employment of compressed and liquefied acetylene, for instance, comes under the Explosives Act in England, while on the Continent and elsewhere more or less stringent rules are enforced. The action of the English and Continental insurance companies has also much restricted its domestic use.

The value of acetylene for illuminating purposes lies in the intense lighting power it possesses, the burner which replaces the ordinary domestic gas burner only consuming about half a cubic foot per hour. The luminosity of the ordinary coal gas flame has, indeed, been attributed by Prof. Lewes to the partial decomposition of the gas into acetylene in the inner region of the flame, and the subsequent combustion of the acetylene; while, according to M. Pictet, the intense light of the acetylene flame is due to the decomposition of the gas into its elements. This decomposition, which occurs near the base of the flame, is accompanied by the evolution of so much heat as raises the separated particles of carbon to incandescence.

Apart from any dangers attending the use of acetylene, it has hitherto been found impossible to produce a burner which is entirely satisfactory. Probably, mainly on account of the dissociation of the gas, the nozzle of the burner soon becomes carbonized, and, especially when exposed to draught, growths of carbon soon appear round the nozzle and render the flame so irregular as to make it practically useless. This difficulty, which is particularly noticeable where no chimney or draught preventer is used, makes it necessary to frequently clean the burner, an objection which very seriously militates against the domestic use of the gas. The burners in use resemble the ordinary coal-gas burners, but have much smaller outlets, some being only the one-hundredth of an inch in diameter.

Many burners have been introduced to prevent the carbonization referred to, but none have proved entirely satisfactory. The burner of Naphey, of New York, is, however, said to be the best. It consists of two nozzles arranged at such an angle that the thin round pencils of light which they emit meet at an angle of about ninety degrees, where they impinge, and produce an ordinary batswing flame. The nozzles are so perforated that small currents of air impinge on the base of each flame, and thus ensure the maximum of oxidation without impairing the light, so that carbonization is minimized.

Finally, it should be stated that, although much capital has been invested in the acetylene industry, and there is a reasonable prospect of its somewhat extended use where the conditions are not favourable for the employment of other illuminants, this new handmaiden of science is still only on trial, and has many difficulties to overcome before taking the important place among our lighting agents which has been predicted for her.

CLOUDS.

By James Quick.

To the occasional observer the different types of cloud formed above us appear almost endless. The difficulty he experiences, however, in not being able to assign definite names to them is not surprising when one considers the universal attention clouds have claimed throughout the present century.

Since Luke Howard put forward his classification in 1803, there have been proposed up to the present time something like fourteen systems of nomenclature, and fifty or sixty names to designate different cloud types. These, moreover, emanating from most of the principal observatories and meteorologists throughout the world, have demanded their proper consideration and discussion.

Howard's system, as will probably be well known, comprised three different types of clouds. These were described as follow:—(1) *Stratus*.—"A widely extended, continuous, horizontal sheet, increasing from below." (2) *Cumulus*.—"Convex or conical heaps, increasing upwards from a horizontal base." (3) *Cirrus*.—"Parallel, flexuous, or diverging fibres, extensible in any or all directions." Together with these three fundamental ones, Howard recognized four intermediate forms, compounds of the above.

Notwithstanding the numerous systems of nomenclature proposed later, none has to any extent displaced that of Howard, which gradually came into general use, and continued so, down to recent years.

The classification put forward by the late Clement Ley has many points of interest. It claims attention not only as a new system, but also on account of the physical nature of its definitions presenting a clear idea of the several causes of cloud formation.

Four primary types are here recognized, corresponding to a certain extent to Howard's three fundamentals. The first two, viz., clouds of radiation and interfret, are similar to the original stratus; the third type—those of inversion—comprise the cumulus; and the final division, consisting of inclination clouds, correspond to the cirrus variety. These four primary types are split up, making, in all, twenty-six sub-divisions.

The generally accepted classification of the present day is the International system formed from the nomenclature of Hildebrandsson and Abercromby. It is composed of the following ten types and sub-divisions:—

Low Clouds.	Middle Clouds.	High Clouds.
1. Stratus.	6. Alto-Stratus.	8. Cirro-Cumulus.
2. Nimbus.	7. Alto-Cumulus.	9. Cirro-Stratus.
3. Cumulo-Nimbus.		10. Cirrus.
4. Cumulus.		
5. Strato-Cumulus.		

Examples of some of these types of clouds are given in the plate. The first photograph is a typical example of the stratus variety, which is defined in the International system as a lifted fog in a horizontal stratum. The second picture shows the cumulo-nimbus, or thunder-cloud type.

These heavy masses of cloud, rising up like mountains, towers, or anvils, suggest the terms "anvil," and "turret," which have been applied to them. They are generally surrounded at the top by a veil or screen of fibrous texture, known as false cirrus, and below by nimbus-like masses of cloud.

The next is of the alto-cumulus type; a dense, fleecy cloud, composed of large whitish or greyish balls, with shaded portions grouped in flocks or rows. Finally come those isolated, feathery clouds—sometimes like thin veils—belonging to the cirrus variety, as depicted in the fourth photograph.

Reproductions of original photographs of both cumulus and stratus varieties appeared in Knowledge for August, 1894, from Mr. H. C. Russell, of the Sydney Observatory. Particularly fine and interesting are the two alto-cumulus or "mackerel" sky pictures, while the shades upon the other compounds are exceedingly characteristic.

In the main, as will be seen from the preceding classification, the system of Howard has remained unchanged except by natural growth. Even the International system is professedly only an adaptation, for general use, of the cloud names which had already come into use in different places. It must, moreover, be remembered that a general classification of clouds becomes possible only in view of the fact that cloud-forms are identical in all parts of the world; in other words, that condensation processes take place everywhere in the same way. Nevertheless, it must not be inferred from this that the same cloud-forms are everywhere associated with the same kind of weather. The conditions producing any one particular weather phenomenon vary greatly in different parts of the globe.

It will be seen from the International list above that the lower and middle clouds comprise the first three types and sub-divisions of Ley's system, viz., radiation, interfret, and inversion, and the higher clouds the fourth of these, viz., cirrus. They are sub-divided according to the altitudes at which they occur, thus presenting a more uniform and convenient method for classification.

Considering now, more in detail, the actual mode of formation of clouds and the physical changes involved, radiation clouds are produced by the radiation of the heat from any particular locality and by the consequent cooling and precipitation of the water particles. These clouds, only dependent upon radiation and not upon the motion of the air, are reduced as a matter of fact to one only—fog. Speaking generally, however, of the two terms, fog and cloud, there is no real physical difference between them. A cloud may be defined as a fog viewed from the outside, and a fog as a cloud viewed from the inside.

This formation of fog is, of course, in accordance with the general physical law, that if a mass of air containing water vapour is cooled below its saturation or dew-point, condensation of the vapour will set in. This can easily be shown experimentally by means of the apparatus depicted in Fig. 1. A is an air-pump connected to one of the vessels, C, D, which are large, round bottom, glass globes—the larger the better. C and D are connected together with a stop-cock, B, inserted. The bore of this connecting tube, as well as the orifice of B, should be as large as possible. G is a screw-clamp cutting off communication with the outside air. A little water is poured into D to saturate the air, and the stop-cock B turned off. C is then exhausted by means of the air-pump, and B again turned on. Air immediately rushes from D to C, and in doing so expands and takes up the necessary heat from the remainder, thus cooling the latter below saturation point. A thick fog is produced in D, and may be shown in a more striking manner by arranging a lime-light jet behind D, when brilliantly coloured halos will be seen, varying according to the number and size of the water particles.

Under certain circumstances, two currents, the one colder than the other, may be formed up in the air, moving more or less horizontally and in opposite directions. The

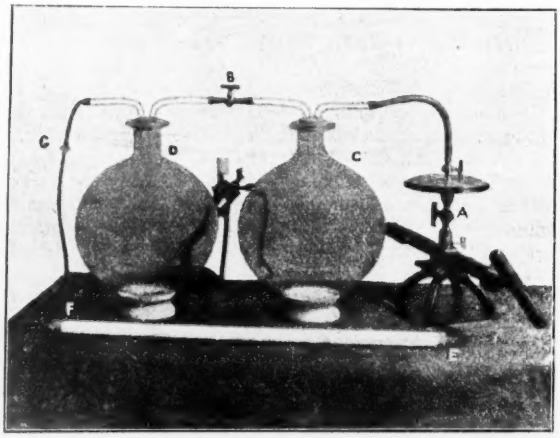

Fig. 1.—Fog-producing apparatus.

one rubbing over the other will produce ripples in the air, such as does a wind blowing over the surface of a lake, but ripples of greater magnitude. In the hollows of these waves the vapour will be condensed and other forms of the stratus type of clouds are thus produced. One variety of these is the well-recognized stratus maculosus or sky, which, compared by some to a flock of sheep lying down, always claims an observer's attention by its quiet beauty.

The next type of clouds are those produced by the ascent of heated columns of water-laden air, which expand and become colder, as has just been explained. Condensation of the vapour takes place, therefore, as it rises into higher and colder regions. In this division occur those massive, woolpack, or heap clouds, the cumuli, together with their compound forms, such as cumulo-stratus or the "anvil" cloud; cumulo-nimbus or the shower cloud; and, finally, the easily recognized and generally disagreeable form of nimbus or rain cloud.

These flat-bottom, extensive, cumulus-clouds, sometimes measuring twenty-five thousand feet from base to summit, present different aspects according to their positions when looked at. Seen, when fairly low down, by the reflected light of the sun, they give to an observer a beautifully brilliant picture to gaze at. When, however, the sun is not shining on the lower portion of the cloud, the bright picture changes generally to one of approaching gloom, and one thinks sometimes of a coming storm. As a matter of fact, however, simple cumulus is by no means a usual cloud of unsettled weather. It is when it commences to unite to form one of its compound forms—say cumulo-nimbus, that rain may be looked for.

The final principal type of clouds, the cirrus, presents a different appearance to the preceding varieties, and offers a somewhat different consideration. When from any cause a layer of air containing water vapour has been carried to a high altitude into layers of rarefied air, which, moreover, are at a very low temperature, condensation will commence as soon as this layer has been sufficiently cooled. The minute water particles thus formed are immediately frozen into ice-dust, producing

those vague, thin, lofty clouds resembling tufts or branches of curled hair, so characteristic of the true cirrus type.

Cirrus clouds and their compounds seem to play an important part in the production of thunderstorms, although the exact action taking place in the formation of the latter is not, perhaps, clearly understood. The cirrus clouds, bristling all over with pointed ice spicules, if brought into the neighbourhood of a cumulo-nimbus cloud highly charged with electricity, would tend to lower the electrical potential of such a cloud considerably by the numerous point discharges. Now the experiments of Lord Rayleigh in connection with this brought out some interesting results. Experimenting with a water jet, he found that by electrifying it feebly, the separate water drops coalesced instead of rebounding from one another as they did before electrification. If, however, the jet was strongly charged—say, with a Leyden jar—the effect was just the opposite. The colliding drops no longer coalesced, but were scattered even more widely than when the jet was unelectrified.

Assuming, then, that the reverse of this action is true—that the separate particles of a cloud when highly charged rebound from one another to a greater degree than when less charged—the action of a cirrus cloud invading the territory of a cumulo-nimbus, or *vice versa*, will perhaps be more clearly understood. The drops will coalesce more when the electrical potential is lowered, and the large-size rain drops accompanying a thunder shower will result.

Coming now to the conditions affecting cloud formation, many circumstances determine when and where the water vapour is condensed. It may rise only a comparatively short height above sea level before the change takes place, or circumstances may require its ascension to high altitudes. For instance, suppose a cold north-east wind, or a south-east wind already laden with moisture, or a lowering of the barometric pressure to set in; all these will tend towards an early formation of cloud. Upon a dry, calm day, however, the vapour will generally have to travel up a long way before it will change its condition. In fact, sometimes, under these circumstances, it only changes into water drops to be directly transformed again into ice particles, resulting in the delicate, fleecy, cirrus variety.

Again, water vapour possesses a good heat absorbing power. A cloudy sky, therefore, or an atmosphere already charged with vapour will, in one respect, check condensation by preventing free radiation of the heat out into space.

But there is yet another and most important item in the programme, the presence or absence of which materially aids or prevents any cloud being formed at all. This essential factor in the atmosphere is—dust. Dust, or minute particles of matter of some description in the air to act as nuclei, is apparently as necessary to the formation of a cloud as the water vapour itself. It is quite possible that a minute water drop *can* be formed without the agency of such a nucleus, but, as has been shown by Clerk Maxwell and J. J. Thomson, unless the water vapour finds something to act as a nucleus around which to form a water drop, it will evaporate away again before it has had time to grow.

Most exhaustive has been the work by Mr. John Aitken, F.R.S., upon the importance, both qualitatively and quantitatively, of dust particles or other nuclei in cloud formation. One of Aitken's experiments illustrating the part played by dust is so striking that, although it will doubtless be familiar to some, it will bear repetition. Referring to the experiment illustrated in Fig. 1, it will be remembered that with ordinary dust-contained air a thick fog was formed in the vessel D when the air contained in the latter was expanded into C. The long tube E F in Fig. 1 is packed with cotton wool, and one end, F, connected to the vessel D by means of a thick walled india-rubber tube. The pinchcock G is now screwed up tight to prevent air flowing in through E F, the stopcock B opened, and the vessels C D then exhausted of air by means of the pump A. B is then shut and G opened slightly to let the outside air flow slowly in at E and get filtered of its dust in traversing the tube. By going through the whole process two or three times, the final air in D will be quite dustless. The pinchcock is then again screwed up and the air in D expanded by opening the stopcock. No fog or cloud will be observed, and the brilliantly coloured halos obtained before will be conspicuous by their absence. Large drops of water will trickle down the sides of the vessel because the latter will offer a surface upon which the vapour can deposit its burden.

In view of the above result it can be seen why the well-known Scotch mists are so different to many others; why the drops are so big and at the same time few. The atmosphere in some parts of Scotland being so pure, so comparatively free from dust and dirt, there are very few particles of the latter round which the vapour can condense.

Illustrative also of this point, but in the other extreme, the dense, thick fogs of our cities tell their own tale of manufactories and fires and of the products of combustion in the air. With nuclei in abundance and other conditions satisfied, the water vapour has no difficulty in finding rocks upon which to build its numerous water-drop castles.

Although it is conclusive that water vapour must have nuclei around which, as centres, it can condense; and, notwithstanding, owing to the immense number of solid dust particles present in the air condensation takes place upon them, yet they are not absolutely essential. It has been shown by Aitken, R. von Hemholtz and others, that in the absence of dust cloudy condensation occurs, but the solid nuclei are replaced by other foreign substances. These may be the molecules of the vapour of sulphuric acid, or the particles given off by anhydrous sulphuric acid, or even from metal surfaces when heated or electrified.

There is yet one further point to be considered, and one which Tyndall first described in his heat lectures. This is the direct influence of sunshine in producing condensation. Tyndall illustrated this by showing the beautiful clouds that result when a beam of light is allowed to pass through a long tube full of dustless, saturated vapour. Furthermore, Aitken has recently found, from similar experiments, that many of the vapours which are called impurities in the atmosphere, such as ammonia, chlorine and several acids, give rise to nuclei of condensation when acted upon by sunshine. Indeed, sulphurous acid and chlorine are thus active, even in the dark, but to a much less extent than in sunshine.

Thus the great wheel of Nature turns—from the sea to the sky, from the sky to the earth, and back to the sea again; this interchange, this complete cycle, working for our good and for the good of everything in general, is ever in action.

A NEW STAR IN SAGITTARIUS.

A NEW star appeared in the constellation Sagittarius early in the year 1898, or possibly in the latter part of the year 1897. It was found from the peculiarities of its spectrum, by Mrs. Fleming, during the examination of the Draper Memorial photographs. The approximate position for 1900, derived

from a photographic chart, using the Durchmusterung positions of adjacent stars, is R.A. = 18ʰ 56ᵐ·2, Dec. = —13° 18′. It was too faint to be photographed on eighty-seven plates, from September 5, 1888, to October 23, 1897, including three plates in 1888, one in 1889, three in 1890, eleven in 1891, three in 1892, twelve in 1893, ten in 1894, twenty-one in 1895, eight in 1896, and fifteen in 1897. On the last of these plates, A 2845, taken at Arequipa with the Bruce telescope, stars of the fifteenth magnitude are shown, but the Nova is invisible. The Nova appears on eight photographs taken in March and April, 1898. In the description of them given below the designation of the plate is followed by the date and the exposure. The letter B indicates that the photograph was taken at Arequipa with the eight-inch Bache telescope, and I, that it was taken at Cambridge with the eight-inch Draper telescope. Both of these instruments are doublets. The magnitudes are estimated by comparison with adjacent stars, and are approximate only, especially since the image was near the centre of the plate only on B 21251, B 21258, and B 21319.

I 20428. March 8, 1898. Ex. 13ᵐ. Mag. 4·7. Estimated 0·1 fainter than — 16°5283, photometric magn. 4·6.

I 20500. March 14, 1898. Ex. 13ᵐ. Magn. 5·0. Estimated 0·5 fainter than — 16°5283, and 0·4 brighter than — 14°5476, photometric magn. 5·6.

I 20612. April 3, 1898. Ex. 16ᵐ. Magn. 8·2.

B 21251. April 19, 1898. Ex. 60ᵐ. Magn. 8·2. An excellent photograph of the spectrum, 3 mm. in length, and showing the lines Hβ, Hγ, Hδ, Hε, Hζ, Hη, and probably Hθ, bright. A broad band, wave length 4643, is also bright, and narrow bright lines are seen at about 4029, 4179, 4238, 4276, 4459, and 4536. These lines appear to be identical with the corresponding lines found in the spectrum of Nova Aurigæ. A well-marked dark line appears at 4060. It will be noticed that in this star, as in Nova Persei, Nova Aurigæ, Nova Normæ and Nova Carinæ, the line Hε is bright, while in variable stars of long period this line is always dark, being probably obscured by the broad calcium line H. This alone may serve to distinguish between a Nova and a variable. The accompanying dark lines on the edge of shorter wave length of the bright lines in Nova Aurigæ, Nova Normæ, and Nova Carinæ are not visible. The line K, also, is not shown.

I 20738. April 21, 1898. Ex. 9ᵐ. Magn. 8·6.

B 21258. April 21, 1898. Ex. 62ᵐ. Magn. 8·2. The spectrum closely resembles that on B 21251 taken two days earlier, but shows certain marked differences. The broad dark line at 4060 has disappeared, and a narrow bright line appears at 5005, doubtless identical with the principal nebular line, 5007. The hydrogen lines appear to be somewhat narrower and more intense than in the earlier photograph, although the lines in the adjacent stars are nearly the same in both.

B 21290. April 26, 1898. Ex. 10ᵐ. Magn. 8·2.

B 21319. April 29, 1898. Ex. 10ᵐ. Magn. 8·4.

The region of the Nova is included on two, and perhaps three, plates taken at Arequipa on October 7 and 8, 1898, but not yet received in Cambridge. They will later furnish important information regarding the rate of diminution of the light. On March 9, 1899, the morning after the discovery of the Nova, a faint image of it was obtained through passing clouds, which showed that its photographic image was about half a magnitude fainter than that of — 13°5193, magn. 9·5. On the morning of March 13, 1899, the Nova was examined visually by Prof. O. C. Wendell. He found, first, that its position for 1900 is R.A. = 18ʰ 56ᵐ 12ˢ·2, Dec. = — 13° 18′ 16″. Secondly, that it was 1·52 magn. fainter than — 13°5200, and therefore 11·37 on the photometric scale. Thirdly, that its light was nearly monochromatic with a faint continuous spectrum. This Nova, therefore, like several that have preceded it, appears to have changed into a gaseous nebula. This is also indicated by the faint bright line at 5005, which, as stated above, appeared in the photograph of its spectrum taken April 21, 1898.

During the last four centuries fifteen stars have appeared, which are commonly regarded as Novæ. These stars are, in general, near the central line of the Milky Way. Their average galactic latitude is 11°·2, while if uniformly distributed in the sky it would be 30°. The region whose galactic latitude is less than 30° has an area equal to one-half of that of the whole sky. Fourteen of these stars appeared in this region, and only one (Nova Coronæ) outside of it. Nova Andromedæ and Nova Centauri had spectra without bright lines, and unlike other Novæ. Omitting them, the average galactic latitude of the others is 9°·0. The galactic latitude of Nova Coronæ is 46°·8, and this seems to be the only known exception to the rule that all Novæ having bright lines in their spectra have appeared near the central line of the Milky Way. Omitting this star, the average galactic latitude of the other twelve is 5°·8. The only Novæ known to have bright lines in their spectra are those which appeared in Corona, Cygnus, Perseus, Auriga, Norma, Carina and Sagittarius. Omitting the first of these, the mean galactic latitude is 4°·6. The probability that such a distribution is due to accident is extremely small. Edward C. Pickering.

March 14th, 1899.

AN ANGLO-SAXON "STORY OF THE HEAVENS."

By E. Walter Maunder, F.R.A.S.

I CHANCED on one occasion to be present at a debate in a literary society on the subject of "Education." The gentleman who opened the debate spent most of his time in expatiating at great length, and with many repetitions, on the profound ignorance of our forefathers. We were reminded that up to comparatively recent times even the nobility could neither read nor write, and that education scarcely had an existence in this country until the institution of School Boards rather late in the Victorian era. I was the only person who ventured in any way to call in question this sombre picture of the past, and my statements on the other side were received with marked incredulity.

This little experience has suggested to me that perhaps it might not be unwelcome to some readers of Knowledge to have some short account of a little popular manual in astronomy—popular in a two-fold sense, as being written for "the unlearned," and as enjoying a wide circulation—which was current in this country very nearly a thousand years ago. I take astronomy as an example, partly because it is the oldest of the physical sciences, and because a widespread attention to it is clear evidence of a state of education fairly advanced in several directions as well as of an attachment to knowledge for its own sake.

The little manual in question appears to have been written during the reign of Ethelred the "Unready" (*i.e.*, the uncounselled or ill-advised), a time of violence and disturbance, which can have been by no means favourable for a general cultivation of science. The book is an abstract in the vernacular of a Latin treatise by the Venerable Bede, "De Natura Rerum." The author of the abstract is not known, but it has been ascribed with some probability to Ælfric, the "grammarian," and translator of a large portion of the

Old Testament Scriptures, and, indeed, its style is not unlike in its clearness and simplicity the "Homilies" for which he is famous.

As was necessarily the case in a book intended for wide circulation before the invention of printing, the treatment is exceedingly concise, and the whole book does not exceed in amount five pages of KNOWLEDGE. In this short space we have the creation of the world treated of, the nature and typical significance of sun, moon, and stars, of the first day of the world and of the vernal equinox, of night and its divisions, of the year and the zodiac, of the relations of the sun and moon, and of their movements, of the time of the equinoxes and the solstices, of leap year, of meteors and comets, of wind, rain, hail, snow, and thunder.

The book bears the name, when complete, of "De Compoto," but occasionally it is found without its first chapter. The second chapter is entitled "De primo Die Sæculi."

The first point which would, I think, strike most modern readers is the clearness with which the writer has grasped the fact of the rotundity of the earth. It is clear to him that the earth stands in empty space, having the heavens as far below it as they are high above it. This, he teaches again and again, sometimes directly, sometimes incidentally.

> "Seo heofon belycth on hyre bosme ealne middan-eard, and heo æfre tyrnth on butan us, swiftre thonne ænig mylnn-hweol, eall swa deop under thyssre eor'dan swa heo is bufan."

"The heaven envelopes in its bosom all the middle-world, and it always turneth about us, swifter than any mill-wheel, all as deep under this earth as it is above." Similarly, he describes how our "earthly night soothly comes through the earth's shadow, when the sun goeth in the evening under this earth, then is the earth's broadness betwixt us and the sun so that we have nothing of her lighting till she is at the other side uprisen." "Assuredly it is a wonderful thing that this worldly night is nothing but the earth's shadow betwixt the sun and mankind." Again, "the earth stands in the very middle through God's might, so fastened that it never moves higher or lower than the Almighty Shaper, who holds all things without effort, has established it."

He gives a proof of the form of the earth incidentally by remarking "truly the day of equinox is one for all the world, and equally long, and all other days in the twelve-month have different lengths. In some lands they are longer, in some shorter, through the earth's shadowing and the sun's going about. The earth stands in the likeness of a pine-nut, and the sun glides about it by God's setting, and on the end where she shines it is day through her lighting, and the end that she leaves is overcast with darkness till she is thither returned again. Now, it is the earth's roundness and the sun's going about that prevents the day from being in each land equally long."

I think we may pause here to note how greatly in advance our author was of those who in recent times have been bitten by the stupid "flat-earth" opinion. He clearly had a sufficient grasp of spherical geometry to see that the variation in the length of the longest day in different latitudes was explicable only on the theory of the rotundity of the earth.

It may be pointed out, on the other hand, that he places the earth in the centre of the solar system, and makes the sun and the stars revolve round it. This and another error to which we shall allude presently are the only two of any consequence in the entire manual, which on the whole is written in a strictly scientific spirit, that is to say, it is based upon actual observation and on strict and careful reasoning therefrom. Nor is his following of the Ptolemaic theory a departure from this. For it is clear that he had no sufficient means of disproving it, and it amply sufficed to explain such observations as he could make.

The geographical information which had reached him varies in accuracy. He correctly speaks of India as lying partly within the tropics. "In the land of India turn their shadows in summer southward and in winter northward." But he is mistaken when he places Alexandria actually on the Tropic of Cancer. "In Alexandria goeth the sun right up on the summer solstice at midday, and there is no shadow on any side." But a line or two further he states quite correctly, "In the land that is called Alexandria the longest day has fourteen hours," which is exactly correct. For Italy he gives the longest day fifteen hours—correct for Campania; and for England seventeen, which is its duration in Northumbria, the land of Bede, the author of the work he is popularizing.

He is quite clear as to the division of the earth into the five zones; although of course no report had reached him of any hardy voyager who had penetrated south of the equator. "Then there are," he writes, "on two sides of the torrid zone, two parts that are well meted, neither too hot nor too cold. In the northern part dwell all mankind." Nor does he seem to have known of any exploration within the Arctic circle, for his description of "Thile" is that it is an island where there is no night for six days at the summer solstice, as the sun then sets and immediately rises again.

As this little manual was clearly intended not for the learned—that is to say not for the monks and clergy—but simply for the common people who could speak and read no language but their own, and to whom Latin, then the universal language of the cultured, was a sealed book, its author has thought it well to add a little caution here and there where he thought there was a danger of his descriptions being misunderstood. He therefore supplements his description of the long summer days of Thile by the emphatic caution that "there is always in a day and night, four-and-twenty hours," neither more nor less.

His description of the stars though very brief might, we have much reason to fear, put to shame the ignorance of many thousands of dwellers in English towns and cities of to-day. He describes clearly how certain constellations, as, for example, the Great Bear, never set in England, whilst other constellations round the South Pole never rise here, and we, consequently, know nothing of them. He points out, too, that there is not only a North Pole star, round which the whole heavens appear to revolve but which itself moves not, but there is also a southern one, "for on these two stars the firmament turns as a wheel turns on the axle." Other stars, again, both rise and set, going from east to west, and are visible at different times in the year. Thus, the Pleiades "through all the summer go at night time under this earth and in the day above; in the winter time they are up at night and down by day."

With regard to meteors, our writer cautions his readers that they must not suppose that they are real stars falling from their places. "Truly there are yet as many stars in heaven as there were at the first when God shaped them." He then mentions the seven planets "which are not fast in the firmament, but have their own going severally," but he considers this too deep a matter to enlarge upon for "unlearned men." Of comets he simply says that they appear suddenly and unaccountably, "and have long rays like a sunbeam. As oft as they appear they betoken something new towards the people that they overshine." This seems the only indication in the little treatise of any leaning towards astrology. Indeed, the writer says

expressly that the Christian man who takes to divination by the moon has forfeited his faith.

He equally repudiates a delusion which is very widely current even at the present time, namely that the position of the moon's horns when crescent betokens the kind of weather that is to come. "If the sun lights him from above then will he stoop, if she light him right through then he will be equally horned." (The sun, of course, in Anglo-Saxon is always feminine, the moon masculine.) "Now argue some men who do not know this reason that the moon turns him as the weather shall be in that month; but never from his nature will weather or unweather turn him." On the other hand he fully believes "that trees hewn down at the full moon are both harder against worm-eating and longer lasting than those hewn at the new moon."

Similarly he evidently regards eclipses, whether of the sun or moon, as perfectly regular instances in the order of the universe and not in the least as portents to alarm men. He carefully explains the causes of both kinds of eclipse, and mentions that the moon's orbit does not coincide with the ecliptic, but that he goes both to the north of it and to the south, and that it is when he is new and when his track coincides with that of the sun, that he is able to eclipse her. Then comes the remark so common in all the ancient notices of eclipses, "and the stars appear as at night." It should be remembered that total eclipses of the sun were by no means so unknown in England in the Saxon period as they have been for the last seven hundred and fifty years. There were no fewer than five which had occurred in the four hundred years preceding the publication of this little manual. One, indeed, had taken place during the lifetime of our author, but seems to have been total only for Cornwall, which was not then part of England. It is very curious that in all these ncient records, whilst we find absolutely no notice of that which strikes our attention so forcibly in eclipses nowadays—namely, the shining out of the corona—we are told of the appearing of stars, a phenomenon which by no means forces itself on the attention, unless perchance, as in the eclipse of last year, Venus or Jupiter happen to be near the sun. Can it be that the corona was less conspicuous then?

There are several other points of interest in our treatise. For instance, his explanation of leap year is a model of brevity and clearness, and he is careful to explain that it has nothing whatsoever to do with Joshua's miracle. He fixes the day of the vernal equinox as St. Benedict's Day, March 21st, and not Lady Day as some considered it to be. One little bit of traditional superstition shows itself, when he says that "the equinoctial day was the fourth day from the shaping of this world. On the fourth day from the shaping of this world, the Almighty Shaper made the Sun and set her in early morning in the mid east, where is told the equinoctial circle. The same day He set the moon full in the evening in the east, together with shining stars in the course of the harvest equinox." Of course he overlooked the fact that if the sun was suddenly called into existence at any moment of time, it would be rising in the east only to places on one particular meridian. But the oversight was a very venial one in the Saxon, who wrote at a time when the known inhabited world was not only confined in latitude to the north temperate zone, but also in longitude to no more than six hours at the very outside. Then, again, though they might have reasoned it out that local time must differ from meridian to meridian, yet they had absolutely no means of determining it. Nor have we any reason to exalt ourselves against our forefathers when we see in our own day—a day of chronometers and watches, of standard and railway time, and of telegraphs—that precisely the same superstition, with the solitary substitution of the autumnal equinox for the vernal, has attained an immense circulation in the writings of sundry quack *soi-disant* chronologists.

We cannot give equal space to the other points that are still worthy remark. Ælfric—if Ælfric it was—explains exceedingly clearly the cause of the moon's phases, and points out that no matter how little or how much of her surface is illuminated she always in truth remains a perfect orb. Here, however, analogy leads him into a serious mistake. For recognizing that the moon and planets shine by reflected sunlight, he generalizes hastily that the stars owe their light to the same cause.

This mistake is partly the reason why he attains to what, under all the circumstances, we must consider a very advanced view of the size and distance of the sun. Seeing that the stars shine at night, and believing that they receive their light from the sun, he is compelled to think "that her light ascends by the side of the earth, and lights up the stars above us." He infers, therefore, that "the sun is exceeding great; all as broad she is as all the whole compass of the earth, but she seems to us very narrow because she is very far from our sight." "Also the stars that seem little to us are very broad, for they might not send any light to earth from the high heaven if they were so small as they seem to our eyes." Then he argues that the moon must also be very great, inasmuch as in a total eclipse he hides the sun. It is, however, far less distant from us than the sun, for "soothly the moon's year has seven and twenty days and eight hours. In that time he underruns all the twelve signs that the sun goes under in twelve months. The sun's running is very wide because she is very high up; the moon's running is very narrow, for of all the planets he runs the nethermost and to the earth the nearest." The brevity of his treatise does not allow him much indulgence in analogy or illustration, but on this one occasion, to make his point quite clear, he continues, "now that thou mightest understand, that a lesser going around hath the man who goes about one house than he who goes round all the burgh, so also the moon hath his running quicker run out on the lesser circuit than the sun hath on the greater." May we not see in this little analogy the germ of that wealth of illustration, metaphor and anecdote with which the Lowndean Professor makes the science of astronomy so vivid and delightful to his audiences to-day?

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE NEED FOR A BETTER INTERCHANGE OF SCIENTIFIC THOUGHT.

To the Editors of KNOWLEDGE.

SIRS,—Startling as it may appear, it is yet a fact that the term "specialist" implies ignorance — ignorance of many things. There are but twenty-four hours in a day, throughout some of which "No man can work."

Further, since the modern tendency is for us all to become specialists, one is led to fear that there must be a growth of ignorance. Better so perhaps than that we should find ourselves contented to jog along as "Jacks of all trades." Let us, however, look the possibilities of danger in the face. Is it conceivable that a time will come when our mere dabbler in various sciences must be regarded as a man of great importance? It seems so, for a time will surely come when we and our descendants will

have specialized to so great an extent that there will be no common ground upon which we, or they, can meet.

If, then, we are all to become specific parts, or volumes, of one great book, there must ultimately be an outcry for the index, or, at best, the synopsis of chapters. Where will it be found?

Both sciences and arts have been lost in the years which have gone before!

Our case is by no means fully stated here, but the effort has been made to indicate the lines upon which it should be argued.

A time may come when there will be a need of authoritative advice upon some question of pure or applied science, and there will be difficulty in finding the Oracle amongst the number of temples which will have arisen.

For this reason it seems imperative that some scheme for the better interchange of thought should be set on foot.

Any deliberative body attempting to set forth the propaganda of such an institution must carefully avoid the introduction of that social aspect which would, from the outset, discount the success of such a scheme (even to damnation) more assuredly than has been the case already, in some instances, which must here be taken as excellent examples of what to avoid. Admitting that social functions are pleasant, yet we must specialize just so far as to leave them severely alone.

If an instance should be required to make clear the dangerous shoals upon which we seem to be going, full speed ahead, let us suggest a simple one, which should appeal to all. If a dental operation is to be undergone, well, the *general practitioner* is the man who saves the situation—from at least much of its possible pain, by the kindly administration of the anæsthetic.

Trusting that enough has been said to indicate a want, and regretting that space does not permit of suggestions as to how it may be met, it seems incumbent upon us, for the moment at least, to leave the matter.

23, Pembroke Road, W. HOWARD LITTLE.

MIRA CETI.

To the Editors of KNOWLEDGE.

SIRS,—Continuing my observations of o Ceti (Mira), during the passing apparition, my estimates of its light are as follows:—

1898.		Mag.
Novem.	24-26 ...	3·90
,,	29 ...	4·00
,,	30 ...	4·07
Decem.	1-2 ...	4·30
,,	4 ...	4·40
,,	5 ...	4·50
,,	6 ...	4·55
,,	10 ...	4·77
	12 ...	4·70
,,	13 ...	4·80
,,	14 ...	4·85
,,	19 ...	5·10
,,	20 ...	5·15
,,	21 ...	5·45
,,	24 ...	5·50
,,	25 ...	5·40
,,	27 ...	5·50
,,	28 ...	5·40
,,	29 ...	5·55
,,	31 ...	5·65

1899.		Mag.
January	1 ...	5·75
,,	2 ...	5·70
,,	6 ...	5·95
,,	7 ...	5·90
,,	8 ...	6·00
,,	14 ...	6·55
,,	16 ...	6·40
,,	22 ...	7·00
,,	24 ...	7·2
,,	28 ...	7·1
,,	29 ...	7·2
,,	31 ...	7·1
February	1 ...	7·05
,,	22 ...	7·7
,,	27-28 ...	8·1
March	2-3 ...	8·10
,,	9 ...	8·00

The star is now too low in the city smoke for further useful observations. The gaps in the observations are due to bad weather, as no opportunity for an observation was missed.

Putting the maximum at October 4th, Mira was then thirty-five days late, as that phase, following the terms of the second catalogue, and the data of previous years, as given in "The Companion," was due August 31st (not in July, as stated in my last note).

The approaching minimum will be watched for.

Memphis, Tenn., U.S.A., DAVID FLANERY.
16th March, 1899.

THE LOVE-GIFTS OF BIRDS.

To the Editors of KNOWLEDGE.

SIRS,—With reference to the love-signs of pigeons, I find I was guilty of a mis-quotation in the April number of KNOWLEDGE in stating that the male pigeon inserts his bill into that of the female. The contrary is the case. Also, the strongest males (independently of their being the best fliers) are the most likely to offend against the exemplary moral law of the genus.

CHARLES A. WITCHELL.

Science Notes.

A new way of preserving milk has been tried, after which it retains all the properties of the fresh article. New milk is cooled down directly, and treated to pure carbonic acid gas under a pressure of five or six atmospheres for four or five hours. This kills all germs which require oxygen or aërobic bacteria. Then the milk is subjected to a pressure of five atmospheres in the presence of oxygen for five hours, after which all germs that will not flourish in contact with oxygen, but obtain their supply from the substances they live upon, or anäerobic bacteria, are found to be destroyed. In transit the milk is carried in vessels containing oxygen under two atmospheres' pressure, which may be in the form of syphons.

To distinguish unpasteurized milk, Professor Storch has elaborated a useful test, and this in connection with the Danish law which does not allow skim milk or buttermilk to be sold that has not been heated to eighty-five degrees Centigrade, in order to limit the spread of tuberculosis. Babcock found that hydrogen peroxide is decomposed by the fibrin of milk, cream is more active than whole milk, while skim milk has less effect, and milk heated to one hundred degrees Centigrade has none. The limit as determined by Storch is seventy-nine degrees Centigrade, milk heated up to that temperature still being able to reduce hydrogen peroxide. To perform the test a teaspoonful of the material, be it cream, milk, or whey, is shaken in a test tube with a drop of peroxide of hydrogen, some strong sulphuric acid, and two drops of an indicator (*paraphenylendiamin*). Milk or cream immediately colours indigo blue, and whey violet red brown, if not it has been raised to seventy-eight degrees Centigrade. If raised to seventy-nine or eighty degrees, the milk or cream becomes greyish-blue, while if it has been subjected to a temperature of more than this it remains white or has only a slight violet tinge.

Now that out-door experiment by the amateur photographer may be carried on under the best conditions as regards duration of light and variety of scenery, a good and handy camera is a desideratum. In this connection, possibly no better instrument can be obtained than the "Gambier Bolton" Camera, made by Messrs. W. Watson & Sons. It is moderate in price, can be used as a hand-

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camera, or on a tripod stand, requires one lens only, has the advantage of a reversing back, square shutter and finder, and that most ingenious contrivance, the automatic release.

What promises to be one of the most valuable geographical works ever published will shortly be issued by Messrs. George Newnes, Limited, under the title of "The International Geography." The volume will be international in authorship as well as in scope, no less than seventy leading geographers, each the highest authority on the section with which he deals, having taken part in its preparation. Among the authors on general geographical principles are Dr. A. M. W. Downing, F.R.S., who writes on mathematical geography; Sir John Murray, F.R.S., on the oceans; Prof. J. Arthur Thomson on the distribution of living creatures; and Dr. J. Scott Keltie on political and applied geography. Various parts of Europe are described by such distinguished geographers as Prof. A. de Lapparent, Prof. A. Penck, Dr. Thoroddsen, Prof. A. Phillipson, and Prof. A. Kirchhoff. Among the authors dealing with different parts of Asia are Sir G. S. Robertson, Sir C. W. Wilson, F.R.S., Mrs. Bishop, Dr. H. O. Forbes, and Captain E. de Vasconcellos. The Hon. D. W. Carnegie, the Hon. J. W. Reeves, and Sir William Macgregor occur among the authors on parts of Australasia and Polynesia; Profs. W. M. Davis and A. Heilprin on North America; Sir Clements Markham, F.R.S., Dr. W. Sievers, and Mr. J. Rodway on Central and South America; Dr. J. W. Gregory, Sir H. H. Johnston, the late Sir R. Lambert Playfair, and the Right Hon. James Bryce, M.P., on Africa; and Dr. Nansen and Sir W. Martin Conway on the Polar regions. The whole work is edited by Dr. H. R. Mill, who has devoted the best part of two years to its preparation. Judging from the prospectus and the names it contains, the volume will be an indispensable handbook of geography.

The "Biokam," an instrument for amateurs interested in the production of *living pictures*, is a novelty put on the market by the Warwick Trading Company, and strikes us as being eminently adapted for bottling up, so to speak, those animated scenes, incidents and phenomena, when for reasons, general or special, their reproduction may serve some useful purpose. The "Biokam" is so compact, portable, moderate in price, and easy of manipulation, that it bids fair to attain the same degree of popularity as the ordinary camera. Indeed, the film, twenty-five feet in length, and containing as many as seven hundred pictures, can be wound on a sort of creel and developed as easily as an ordinary plate. The exposure, by means of a train of wheels, can be effected at such a speed that each separate impression is practically instantaneous, and thus an unlimited number of midget portraits or photographs of scenery may be taken with a minimum of trouble. The instrument is provided with two lenses—one for negatives, the other for projection purposes, by which means living pictures taken by the amateur himself may be thrown upon the screen for his own delectation and that of his friends.

We have received many letters in reference to a communication addressed to the *Times* early in April, and signed "Knowledge." The letter in question did not emanate from us.

BRITISH ORNITHOLOGICAL NOTES.—These Notes are unavoidably held over until next month.

Notices of Books.

Recent Advances in Astronomy. By A. H. Fison, D.SC.(LOND.). The Victorian Era Series. (Blackie & Son.) "Under the general editorship of Mr. J. Holland Rose, M.A., late scholar of Christ's College, Cambridge, the individual volumes are contributed by *leading specialists* in the various branches of knowledge which fall to be treated in the series." It is therefore passing strange that Mr. Rose should have selected for his author one whose work lies outside the domain of astronomy. It is especially evident in the last three chapters, dealing with the analyses of sunlight and starlight, and with the red flames of the sun, that Dr. Fison is an "outsider" in astronomy, and that his own work has been in the terrestrial laboratory, not in the celestial. He treats very well of the fundamental laws of light and chemistry, and shows how they are adaptable to astronomical research; but these adaptations were made a quarter of a century ago, and Dr. Fison has scarcely attempted to follow them in their application in the regions of pure astronomy. He goes fully into any laboratory experiments in chemistry that may bear on astronomical results. He touches lightly on the stellar velocities in the line of sight. He just mentions the Harvard spectral surveys; but we look in vain for any discussion of the spectra of sunspots and faculæ, for any mention even of the broadening or "reversal" of lines over them. Above all, he does not touch at all on the knowledge that we have obtained in the later Victorian age through eclipses, of the sun's chemistry or the sun's surroundings—without which surely the analysis of sunlight is scarcely even begun. To his readers the "corona" is something that no two people see alike—like the rainbow. In his study of Mars, Dr. Fison's limitations are less noticeable, seeing that his treatment is based on purely theoretical considerations. In the first two chapters also, bearing on the life-history and distribution of the stars, he does excellently, in so far as he deals with mathematical or theoretical conditions. We would like to protest, however, against the introduction into a work that deals with the facts not the fictions of astronomy, of Mädler's absolutely baseless suggestion of a great central influence in the Pleiades. In his ingenious simile also of the distribution of stars to the conditions of things imagined in the kinetic theory of gases, he suggests that the stellar system will eventually disintegrate through the escape of members acquiring high velocities (like Groombridge, 1830), forgetting that increase of velocity attained by one star means the decrease by another, and that the process tends rather to aggregation. Had Dr. Fison had a practical training in astronomy, and had he still further confined the departments of this science of which he treats (for the volumes of this series are quite small), his book would be an admirable one, for he is careful in his work, his style is good, and his judgment clear and critical.

Landmarks in English Industrial History. By George Townsend Warner, M.A. (Blackie.) 5s. As regards matter, the author makes no claim to originality in these pages; but, as each historical event in England's industrial and commercial progress in the past is important, not only by itself but also in its bearing on other events, the grouping of events round chief landmarks or epochs is intended to bring out these connections more fully; it is in this co-ordination of agricultural, mechanical and economic historical information that the novelty of the book consists. Chronological order is thus, to some considerable extent, traversed; indeed, the book really consists of a number of essays, in which certain topics are selected, such as the rise of banking, machinery and power, trade and the flag, trading companies and colonial expansion, towns and gilds; and thus the author seeks to convey broad, general notions of the great factors in our civilization. The plan is very good. Instead of the history of kings and queens we get the broader and larger history of the people and their institutions. In place, however, of one slight volume for so gigantic a task, very many would be required to give anything like an adequate account on the same lines as here carried out; it is but fragmentary at best—an amputated appendage of a great idea, and taken as such it is a book which will be read with interest.

Outlines of Industrial Chemistry. By Dr. Frank Hall Thorp. (Macmillan.) Illustrated. 15s. net. Apparently, at the outset, the author, or rather the compiler, of this book, intended to cover the whole range of industrial chemistry—a very laudable

ambition, but it failed, as all like attempts must fail in dealing with the colossal subject of applied chemistry in all its branches within the narrow limits of a comparatively small volume. One might as well try to cram a hundredweight of coal into a quart pot. The book before us is an American production, the object of which is "to furnish an elementary course in industrial chemistry." Acids, alkalies, glass, pigments, coal-gas, mineral oils, soap, candles, explosives, dyeing, paper, leather, glue, and a multitude of other products and processes are included in this so-called technical course. No student ever requires such a miscellaneous collection of expert knowledge. A student who has gone through courses of inorganic and organic chemistry, with the usual analytical work in the laboratory, can readily adapt himself to any *special* line of work, but if he devotes himself, say, to the *ceramic industries*, he will certainly not glean his information from a book of this kind, in which the subject is despatched in a few pages. Analytical processes are omitted as being foreign to the scope and purpose of the book; metallurgy does not find a place because there are many good books on the subject; the coal-tar colours have been condensed into the briefest possible outline because usually included in courses in organic chemistry. By a similar process of reasoning, quite as legitimate, the author might have eliminated all the rest of the book. Candles and paraffin, for example, are organic as well as the coal-tar colours; on metallurgy there are certainly many books, and so there are on soap-making, glass manufacture, etc., and it is absurd to exclude analysis from such a work because the substances treated of, in many cases, require special methods. The author himself says that a chemical library will be necessary to supplement what he advances. The book is good enough, as far as it goes, but we in England, who have plenty of chemical dictionaries, and special works on all, or nearly all, the subjects here included, do not require such a work, the importation of which from America is very much like "carrying coals to Newcastle." In these days of cheap printing, 15s. net is a prohibitive price for so slim a volume.

Birds of the British Islands. Drawn and described by John Duncan. (Walter Scott, Limited.) 5s. This book forms nothing more than a collection of pen and ink drawings of British birds, with a short description of each bird, and a very brief and not always accurate account of its distribution. Nothing, therefore, of an original nature can be claimed for the letterpress. If there is any value attached to the book it lies in the author's drawings, which have appeared from week to week for the last ten years in the *Newcastle Weekly Chronicle*. Some of the drawings are very fair and accurate pen and ink sketches, but the majority appear to us as stiff and formal—as though the author had taken stuffed specimens as his models.

The Discharge of Electricity through Gases. By J. J. Thomson, D.SC. (Constable.) Illustrated. 4s. 6d. net. Consists of an expansion of four lectures on Discharge of Electricity through Gases, given at the University of Princeton, New Jersey, 1896. The relation between matter and electricity is best studied by matter in the gaseous state, because the properties of a gas and the laws it obeys are simpler than for either a solid or a liquid, and the kinetic theory of gases supplies us with the means of forming a mental picture of the processes going on in a gas which is lacking for matter in its other states. Professor Thomson here deals with this subject in a most profound manner—profound, let us explain, in frigid contrast with that sort of popular, scientific literature which is intelligible to the meanest capacity. To some, though well equipped in general scientific knowledge, many of the ideas advanced will appear as through a glass darkly. In the purely experimental portions, such as the deflection of rays by a magnet, and the thermal effects of rays; electrification of gases by the splashing of liquids, or by chemical means; and the conduction of gases and so on, it is easy to follow the clear delivery of the Professor; but when theories in explanation of the many and diversified phenomena involved are under consideration, then the mists descend and envelope the reader. Still, for a work of this kind, we could hardly expect a more intelligible presentation of the results obtained in the new field opened up by the advent of the so-called Röntgen rays.

A History of Astronomy. By Arthur Berry, M.A. (John Murray.) We must confess to a strong feeling of disappointment with Mr. Berry's book. Though entitling it "A History of Astronomy," and designing it as a text-book for study and reference for University Extension students, it contains little of value that has not been often given before, and given better and far more brightly by books that are now half-a-century old. Thus, though Mr. Berry professes to give "an outline of the history of astronomy from the earliest historical times to the present day," in his chapter on "Primitive Astronomy," he devotes but eleven lines to the "Progress due to early civilized peoples—Egyptians, Chinese, Indian, and Chaldæans"—and euphemistically characterises this little paragraph as not being a "*connected account.*" The rest of the chapter is given over to the definitions of the celestial sphere, and of its circles and poles, of direct and retrograde motions and stationary points, of occultations, of the measurement of time and of the lunar month of eclipses, and the saros. Chapter II. deals with Greek Astronomy, and Chapters III. to XII. tell of the slow progress of astronomy, and of the lives of the astronomers or mathematicians during the long centuries of the Middle Ages until the great Astronomical Renaissance at the very end of the eighteenth century. This occupies pages 76 to 353. But to astronomy in the nineteenth century but one chapter is given. The chapter contains just fifty-five pages, and considering the scope of the subjects it deals with, its style somewhat resembles an auctioneer's valuation list. Is this because Mr. Berry wishes to give a slap to the dying century's conceit in the works it has wrought and the progress it has made in its hard spent life? Or, is it that Mr. Berry was too indolent to attempt a subject which it would have cost him time and research to master? Judging from the preface, we should say that the latter was the true explanation. Mr. Berry congratulates himself on saving "a good deal of space" by these omissions. His principle carried out to its logical conclusion would have resulted in the "saving" of the entire volume, nor do we think that the intellectual life of the end of the nineteenth century would have been materially injured thereby.

The Way the World went Then. By Isabella Barclay. (Stanford.) Illustrated. 4s. A very useful reading book for the higher standards of elementary schools. The authoress infuses into the story of the earth's history a little of the romantic element, not too much, but just sufficient to impart a proper relish for the intellectual nourishment she has to offer. Written with the object of instructing a child of the deceased author's friend, the present editors express a hope that the book may appeal to other young people, and we think they will not be disappointed. The illustrations are vivid and the style easy. If the authoress has sometimes soared into the realm of imagination at the expense of slight perversions of the truth, the warm colouring of her images perhaps more than compensate for this liberty, and we trust that many of the rising generation may profit by this little history of our forefathers—men of the stone age, the bronze age, the lake dwellers, and the sea-kings. The price is rather high for so slight a production.

An Intermediate Text Book of Geology. By Charles Lapworth, F.R.S. (Blackwood.) Illustrated. 5s. Founded on the text of the late Professor Page's Elementary Geology, this work, in its extended form, is "no longer wholly elementary in its character." Most of the chapters have been recast; the sequence of subjects is that adopted in its prototype, but, with the exception of occasional paragraphs, the letterpress has been re-written, and the free interpolation of new matter has swollen the size of the volume more than a hundred pages. The care which the author, aided by many experts in different branches of the science, has bestowed on the work in bringing it up to the present state of knowledge invests it with the character of a new production, and students, we think, may rely on it as a safe guide in systematic work.

Annual Report of the Board of Regents of the Smithsonian Institution, 1896. (Government Printing Office: Washington.) Illustrated. This extremely useful volume contains the proceedings of the Board of Regents, report of the Executive Committee, exhibiting the financial affairs of the Institution, and the report of the Secretary, giving an account of the affairs of the Institution, accompanied with statistics of exchanges, and so on. A general appendix contains a selection of memoirs of the highest interest to those engaged in the promotion of knowledge: thus, Professor Dewar's researches on liquid air; Cornu's investigations of the physical phenomena of

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the upper regions of the atmosphere; Martin's utilization of the Falls of Niagara; Le Conte's earth-crust movements and their causes; Michael Foster's recent advances in science and their bearing on medicine and surgery; and Schweinitz's war with the microbes, are all here reprinted from various sources. These papers, and many others, beautifully illustrated, form a miscellaneous collection, embracing a considerable range of scientific investigation and discussion; they depict the more remarkable and important developments in physical and biological discovery, and follow concisely the prominent features of recent progress in astronomy, geology, mineralogy, anthropology, and, indeed, every branch of science.

Chemical Analysis, Qualitative and Quantitative. By William Briggs, M.A., and R. W. Stewart, D.SC. (London: W. B. Clive.) 3s. 6d. The addition of a single chapter of thirteen pages on volumetric analysis is hardly sufficient justification for referring to this little book as one on quantitative analysis. The first six chapters, of one hundred and fourteen pages, deal with ordinary test-tubing, which it would appear is still required in some of the examinations for which Mr. Clive specially caters. As a guide to the analysis of a simple substance the book is as good as many others which have been published, but it is in no sense an educational introduction to practical chemistry.

Cressy and Poictiers, or the Story of the Black Prince's Page. By J. G. Edgar. Illustrated. (London: Ward, Lock & Co., Ld.) 3s. 6d. The publishers are to be congratulated upon this handsome re-issue of the late J. G. Edgar's splendid story of the conqueror of Cressy and Poictiers.

Practical Work in Physics. Part 4.—*Magnetism and Electricity.* By W. C. Woollcombe, M.A., B.SC. (Oxford University Press.) Illustrated. 2s. If the art of criticism be the art of praise we cannot criticise this book. The initial statement is inaccurate, or at best incomplete. The first experiment contains a reference to the sixth, and the sixth page contains a reference (*via* a foot-note) to the twelfth. The arrangement throughout is bad. On p. 7 it is stated that if a compass needle lie along the magnetic meridian it is unaffected by the earth's field. The author appears unable to differentiate between the exact meanings of the expressions "at right angles to," "perpendicular to," and "normal to." The second portion of the book is slightly better, though it contains such errors as (p. 54) "indirectly proportional" for "directly proportional," etc. There are too many notes, and too many references, both to them, to the diagrams, and to the appendices. A list of the E.M.Fs. of primary cells is given, matters being in this connection taken to the second place of decimals. If ever a note or a caution were needed, surely it is here. But the illustrations are good, and we find some ingenious suggestion as to the putting together of simple apparatus.

The Renaissance of Girls' Education in England: A Record of Fifty Years' Progress. By Alice Zimmern. (Innes & Co.) 5s. There is no more interesting legacy which the nineteenth century can bequeath to its successor than the present position of women in all fields of human activity, and in no direction have they achieved more than in the department of education. The subjection of women, which John Stuart Mill so brilliantly resisted with tongue and pen thirty or forty years ago, has given place to their emancipation, and they stand upon the threshold of the new era—free. For this emancipation they are in nowise indebted to the lords of creation, but just to their own patience, skill, and perseverance, and the well conceived and admirably written volume before us traces the history of the movement during a fifty years' progress. That movement has effected a peaceful revolution of the highest import for the future, and we do not know a more encouraging story. Miss Zimmern has done her work thoroughly well, and we heartily commend the volume.

The Practical Electrician's Pocket Book and Diary, 1899. Edited by H. T. Crewe, M.I.MECH.E. (London: S. Rentell & Co.) Illustrated, 1s. nett. This little book contains a vast deal of really useful information. There are 130 pp. of just such hints, tables and diagrams, as men engaged on practical work frequently require. The information conveyed is sound, but we trust that in future editions more attention will be paid to the arrangement. And Mr. Crewe must refrain from the building up of sentences which contain two hundred words each! We believe that an edition *de luxe*, say at half-a-crown, would find a ready sale, for while the matter is good, the manner is bad, albeit good at the price. Besides the text and the diary there are other useful features—as, for instance, detachable estimate and requisition forms, and small sheets of squared paper. On the whole an excellent shillingsworth.

West African Studies. By Mary H. Kingsley. With illustrations and maps. (London: Macmillan.) 21s. As the authoress of "Travels in West Africa," Miss Kingsley acquired a reputation for smart and vivacious writing, and the present volume not only maintains her character in this respect, but shows her competency to deal with problems of a graver character connected both with politics and ethnology. Miss Kingsley holds a brief on behalf of English traders and the native population. She has strong views against the present system of governing Crown colonies in which she hopes to make the public participate. She has an alternative method of administration to advance; but her views would probably receive more attention from high authorities if she gave less play to her vein of humour. We can have little to do here with political questions and the fittest form of colonial government, but Miss Kingsley's enquiries into forms of nature, religion, and belief, are within our province. In this portion of the book the author is at her best. There is evidence of wide reading of recognized authorities, and of acute and painstaking observation. The district throughout which enquiries were prosecuted, extended from Sierra Leone to Loanda on the West Coast with occasional visits to the interior, where the Oil Rivers, the Ogowe and the Lower Congo, offered facilities. It is evidence of the care with which the question was studied, that Miss Kingsley was able to recognize four main schools of West African Fetish. The Tshi and Ewe school, which Ellis has described, the Calabar school, and those of Mpongwe and the Fjort schools. Classification necessarily implies discriminating and careful work. We have, of course, not space to enter into the details of Fetish, which the author defines as the religion of the natives of the West Coast, where they have not been influenced either by Christianity or Mohammedanism. Growing out of this subject we have the questions of witchcraft and of native medicine in relation to West African religious thought. These chapters will well repay careful study. Two appendices are added to the book, which should by no means be skipped. These are written by M. le Comte C. de Cardi, and Mr. John Harford, of Bristol, authorities on the subjects of which they treat. The illustrations are good; the index might have been more complete.

First Lessons in Modern Geology. By the late A. H. Green, F.R.S., edited by J. F. Blake, M.A. (Clarendon Press.) Illustrated. 3s. 6d. This book is practically a primer, as one might infer from the title. It has been prepared from manuscript left by the late Professor Green. There is nothing in the style or arrangement to differentiate it from other books of the same kind so far as we are able to discover. From beginning to end the book lacks individuality; it bears a striking likeness to other well-known primers of good reputation.

BOOKS RECEIVED.

The Art of Writing English. By J. M. D. Meiklejohn, M.A. (A. M. Holden, London.)

True Tales of the Insects. By L. N. Badenoch. (Chapman & Hall.) Illustrated.

My Tour in Palestine. By F. H. Deverell. (Eyre & Spottiswoode.) Illustrated.

On Buds and Stipules. By the Rt. Hon. Sir John Lubbock, Bart., F.R.S. (Kegan Paul.) Illustrated. 5s.

The Journal of the Society of Comparative Legislation. New Series. No. 1, March, 1899. (Murray.) 5s. net.

Society for the Protection of Birds. Eighth Annual Report, January to December, 1898.

Rousdon Observatory: Variable Star Notes, No. 4—R Cygni and χ Cygni. By Sir C. E. Peek.

Journal of the Essex Field Club. Edited by Wm. Cole. Nos. 1-24. 6s. per annum.

The Studio: An Illustrated Magazine of Fine and Applied Art. No. 72. 1s. monthly.

"48 Hours" Dispute—July, 1897, to January, 1898. (The Engineering Employers' Federation.)

Report of S. P. Langley, Smithsonian Institution, for the Year ending June 30th, 1898.

China, Anglo-America, and Corn. A Lecture. By Granville Sharp. (*Hong Kong Daily Press* Office.)

Table-Talk with Young Men. By W. J. Dawson. (Hodder & Stoughton.) 3s. 6d.

The Hunterian Oration, 1899. By Sir William MacCormac, Bart. (Smith, Elder & Co.) 2s. 6d.

Notes upon the Romano-British Settlement at Chigwell, Essex. By J. Chalkley Gould. (Epping Forest Museum, Chingford.) Illustrated. 6d.

A Select Bibliography of Chemistry—1492–1897. By Henry Carrington Bolton. (Smithsonian Publications.)

The Photo-Miniature: A Monthly Magazine of Photographic Information. (Dawbarn & Ward.) 25 cents.

Bulletin de la Société Neuchateloise de Geographie. Tome XI., 1899. (Paul Attinger.)

Results of Meteorological and Magnetical Observations, 1898. (Stonyhurst College Observatory.)

Report of the U. S. National Museum for the Year ending June 30th, 1896.

WHAT IS A GEOLOGICAL CATASTROPHE?

By N. A. GRAYDON.

MOST geologists of the present day take the uniformitarian point of view, according to which the general features of the earth's surface are the product of, not sudden catastrophes, but gradual and uniform changes, such as are now more or less perceptibly in progress. There are, however, some special features, the explanation of which seems to demand changes so great and rapid or violent as to make them hardly distinguishable from catastrophes.

Generally speaking, disturbance of conformable strata, such as upheaval, subsidence, tilting, folding, faulting, erosion, etc., may well be conceived as a slow and uniform process, but formation of conformable strata, especially if of different nature, like, for instance, sandstone and limestone, is not easily representable as such; for the sudden transition from the last deposit of the one kind of sediment to the first deposit of the other kind seems inexplicable, without a correspondingly sudden change of level within or without the affected area.

So long as there is no evidence in favour of great and rapid changes of level, it may be right to assume their non-occurrence; but it is, in any case, advisable to reconsider the available evidence on the subject in all its bearings, for some data, such as the preservation, more or less intact, of submerged river valleys in the so-called continental platform, seem to indicate immersion so rapid as to leave no time for the action of the sea's levelling agency.

Under the title of "Sub-Oceanic Terraces and River Valleys of the Bay of Biscay," Prof. Hull, F.R.S., gave in *Nature*, of April 21st, 1898, some details of a typical case. He says: "The Adour passes out to the deep ocean through a continuous deep cañon or gorge one hundred miles long as 'Fosse de Cap Breton.' At thirty miles from the coast the bed of the cañon is three thousand one hundred and seventy-four feet below the general level of the continental shelf. At sixty-two miles it is about five thousand four hundred and forty-two feet below the same level. The cañon can be distinctly traced to the depth of nine thousand feet where it opens out on the oceanic floor."

Accepting this account as correct, the question suggests itself: How is it that this narrow submarine channel has not long ago been filled up with river deposits or other sediments travelling to and fro along the coast under the influence of waves and currents, the action of which is pretty well known and may be briefly summarized as follows:—

I. Motion of the sea caused by the winds does not extend far down. At a depth of thirty to fifty fathoms, wave action is almost imperceptible and current scour ceases.

II. Motion of the sea caused by tidal action is, in deep water, chiefly vertical; it is only converted into horizontal motion in shallow water; tidal currents are, therefore, essentially surface phenomena and their scouring action generally ceases at less depth than wave action.

III. The only deep-water currents of sufficient strength to scour away or prevent deposits are those about submarine ridges impeding the circulation of polar and equatorial waters.

IV. The material of shore deposits has a tendency to travel to and fro along the coast with waves and currents, the maximum action of which is between low and high-water mark, and every hollow in the sea-bed, near the shore, acts as silt-trap for travelling sediments.

Applying these principles to the case under review, assuming, in the absence of evidence to the contrary, that every part of the small Adour basin was subjected to the same total amount of subsidence, which, measured at the old river mouth at the foot of the continental escarpment, appears to be about nine thousand feet, and dividing the period of subsidence into two:—

(A.) Period before submergence of the edge of the continental platform—here, apparently, indicated by the two hundred fathom line—and with it of the terminal headlands of the Adour valley.

(B.) Period after it.

It follows that, at the beginning of period (A), the seashore was at the base level of erosion or the foot of the continental escarpment, and the whole region drained by the Adour was some nine thousand feet higher above sea-level than it now is. It was therefore, better able to intercept moisture-laden air-currents. Precipitation was accordingly, heavier, and the drainage area including, as it did, a region now submerged, was considerably larger than now. The stream's volume must, therefore, have been much greater than at the present time.

The submerged part of the channel presents the very steep fall of from sixty to seventy feet per mile, so the Adour was, then, more a torrent than a river. Its erosive power must have been very great and the amount of sediment borne along very large. The narrowness of the submerged valley—a mere gorge—shows that the rate of erosion of the bed was much more rapid than that of weathering of the sides.

As subsidence progressed the gorge must have assumed the aspect of a long fiord, which, under conditions of slow subsidence, would have soon been filled up with the river's own deposits to the level at which scouring action of tidal currents obtained the mastery—that is, up to, say, the fifty-fathom line. As nothing of the kind seems to have happened, it must be inferred that either the scouring action of the tidal currents extended, here, to a depth far greater than it is known to do anywhere else on the earth, or the rapidity of submergence was such that the amount of sediment brought down by the river during the process was insignificant.

Further, it has been observed that the depth of the sea within a fiord often far exceeds that just without it—this being due to the filling in of the trough, up to scour limit, by the sediments ever travelling up and down the coast. As the process does not extend far into the fiord, the result is a kind of deep bar at the mouth. As there is apparently no such bar in the case of the submerged mouth of the Adour valley, it must be inferred that either there was no shore deposit going on at the time, or the rapidity of submergence was such that the amount of travelling coast sediment trapped by the deep trough during the process was insignificant.

At the close of period (A), the Adour fiord had, at the

mouth, a depth of about seven thousand eight hundred feet, or apparently many times that of the deepest known of Norwegian fiords.

With the advent of period (n) and submergence of the edge of the continental platform, conditions changed to some extent. As the shore line retreated up the gentle slope of the continental platform, every part of the submerged gorge became, in turn, silt trap for the travelling coast sediments, and under conditions of slow subsidence the channel would have been gradually filled up and obliterated from the mouth upwards if not from both ends. As this did not happen it must be again inferred that either there was no shore deposit going on at the time, or the rapidity of submergence was such that the amount of travelling coast sediment trapped by the deep trough during the process was insignificant.

In each case it seems more natural to adopt the second alternative mentioned—that is, great rapidity of submergence—especially as to adopt the other involves a series of implications which have the character of gratuitous assumptions. The question then imposes itself: "What rate of subsidence—and if of subsidence why not of upheaval—constitutes a catastrophe?"

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—III.

By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.

Species.—That true species exist in the myxies is doubted by no one who has studied them, and the constancy of many forms from distant places strongly supports this view. But it may be permitted to doubt whether the range of variation possible to one and the same species is yet sufficiently known to enable us to rely with security upon the whole of the present classification. In the progeny of a common parent when under cultivation, great diversities have been observed in the character of the calcareous walls of the sporangium, in the thickness of the capillitium, and even in its presence or absence, in the colour of the sporangium walls, the capillitium, and even of the plasmodium. Until, therefore, more species have been subjected to observations under culture, or more life-histories have been exactly traced, we must be prepared to regard the specific distinctions as open to revision. Mr. Massie considers that he has found cases of hybridism in myxies; but this, perhaps, requires confirmation.

Whatever be the limits of variation within a species, the great fact of specific distinction seems to admit of no doubt, and one of the most interesting faculties of these pieces of naked protoplasm is the power of knowing other pieces of protoplasm of their own species from the apparently similar protoplasm of other species. According to the concurrent testimony of three of the chief observers of these organisms, Cienkowski, De Bary, and Lister, "union never takes place between plasmodia of different species." "Branches of different plasmodia," says Cienkowski, "crawl near one another, and mutually embrace one another, without showing the least trace of any fusion."

The merging of two protoplasms has been seen under the microscope. "There appeared to be no mutual attraction until the two plasmodia were only separated by a distance of 40 μ. When a lobe from one was pushed out towards its companion, the intervening swarm cells were thrust aside, and they came into contact; the hyaloplasm (ectoplasm) of each blended at a single point, and then a stream of granular matter was seen to pass, then with a return flow of the streaming in the layer of the two, the channel was widened, and a gush of its contents poured into the smaller one, when union was complete and the system of circulation became common to both."

It may be permissible to adduce another instance of organisms of a very simple character to illustrate at once the attractive force of members of one species on their fellows, and of the capacity for selection which makes them reject the members of other, though very similar species. The case we are about to mention relates to two species of the genus *Cutleria*, algæ of a low type.

To the receptive ova of *Cutleria adspersa*, Falkenburg added actively mobile spermatozoids of the nearly allied species *Cutleria multifida*; so like the other species *adspersa* that they can only be distinguished by small external differences. "In this case the spermatozoids, as seen by the microscope, wandered aimlessly about, and finally died without having fertilized the ova of the allied species of algæ. . . . A very different result was obtained as soon as a single fertilizable ovum of the same species was introduced into the vessel containing the spermatozoids. After a few moments, all the spermatozoids from all sides gathered around this ovum, even when the latter was several centimetres distant from the place at which the latter were chiefly collected."

These instances impress the mind with the fundamental character of the fact of species; whether it has arisen from variation and selection or not, it is a fact that goes down to the very foundations and rudiments of organic life, and even there influences the life and habits of the organism. As we see it in the myxies, it precedes the origination of the sexual distinction, it precedes any differentiation of parts or organs, it precedes the development of the cellular tissue. It may, perhaps, be said to precede the division into the animal and vegetable kingdoms. The distinction can exist in small naked bits of protoplasm, and each of these, indistinguishable in structure as the protoplasts of some of the species are to any organs or instruments which we possess, has the power of distinguishing between these indistinguishable masses, of attracting and being attracted by those of its own kind, and of remaining indifferent and neutral towards those of other kinds.

That the pollen of an oak should not act on a daisy seems to us natural; that the naked protoplasm of these minute organisms should be endowed with this selective capacity does seem very remarkable, and may well make one pause and think. Is it possible, one inclines to ask, to feel sure that all the various species of myxies have been produced from one original form by the force of a natural selection? How can the doctrine of the fittest be applied as between two naked protoplasts, and if applied only to the later stages of growth, how has it reacted on the earlier stages?

Classification.—We now propose to deal with the classification of these organisms, and this will afford us an opportunity of describing more in detail some parts of their structure.

The value of characters for the purposes of generic and specific distinctions is a subject well worth consideration, for it often reveals unexpected facts in the correlation of parts, startling one by dividing organisms which, at first sight, seem nearly akin. Colour is for the most part of little value as a distinction in flowering plants, for we know how widely colour will vary in the same species. "Color," says Linnæus, "in eadem specie mire ludit: hinc in differentia nil valet;" and yet in the pimpernel, the blue and red forms differing in scarcely any other character are true and not interchangeable species; in the algæ the

presence of colours other than green is found a fundamental character in their classification, and in like manner we shall find in the myxies that the colour of the spores has been found a character of real value.

What is the meaning, some one may ask, of the value of a character for classificatory purposes? It means that the presence of that character affords a safe line of cleavage; that those plants or animals which are on one side of the line will be found to agree in other characters—will have a likeness in many points of that kind which creates what we call in human beings a family likeness; whilst those organisms which stand on the other side of the line will be found dissimilar from the first family group. For instance, if we gather the common white dead nettle and observe its stalk, we shall find that it is four-sided, so that a section across it is a square. Now this characteristic might easily be supposed to be one of little consequence, and yet, in fact, it will be found to be a true and valuable one, and that all plants with a square stalk and lipped flowers will be found to have a four-lobed ovary and four nuts on the bottom of the calyx, and these belong to the family of the Labiatæ. If now, on the other hand, we count the number of the stamens in plants, and use this character as the foundation of our classes, we shall break up this natural family with its square stems, and shall relegate some genera, such as Salvia, to one class, while the great mass of the family go to another, and, what is perhaps worse, these exiled genera find themselves put into a class together with plants with which they have no real connection or sympathy—with the Enchanter's Nightshade and the Duck-weed. This form of the stem then has a high value as co-existent with a general likeness of structure; the number of the stamens may vary in plants closely akin, and agree in plants widely different, and therefore has a low systematic value.

The variations of form of our domesticated dogs are generally held to be of no value even as specific distinctions; but the difference of the markings in the spores of myxies is held by those who have most studied their classification to be often a safe difference as between two species. It is only by experience that we can tell the systematic value

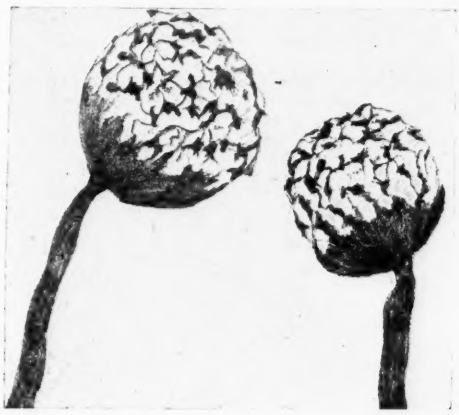


FIG. 5.—*Cribraria aurantiaca* × about sixty diameters.

of a difference—*i.e.*, by observing how far it is correlated with other differences of structure or life-history, and whether the difference does, or does not, lose itself in a series of easy gradations between the two extreme forms. And yet there are some minds whose thoughts so run along the lines of creative thought that, as if by a happy intuition, they are able to seize these crucial points which are of real value, and to reject those that are useless. Such is the mind of the true naturalist.

Some slight difference exists amongst naturalists as to the extent to which the group of the Myxomycetes is to be carried—viz., whether they shall include or exclude a small group of organisms about to be mentioned, and as to the way in which the two terms Mycetozoa and Myxomycetes shall be used in classification. The following table may be useful as indicating the primary and secondary divisions of the group, which we shall accept in its widest signification :—

			Example.
(*a*) Mycetozoa	With an aggregate plasmodium, *Acrasieæ*		*Dictyostelium.*
	With a fused plasmodium, *Myxomycetes*	Exosporeæ, spores borne externally.	*Ceratomyxa.*
		Endosporeæ spores borne internally.	*Arcyria.*

Of these classes, it may at once be observed that the endosporous Myxomycetes are by far the largest, and that the species at present known of the other groups are very few in number, and, accordingly, in the sketch which we have given of the life-history of a myxie we have dealt only with the changes in an endosporous myxie.

It now becomes needful to call attention to the points in which the smaller classes differ from the dominant one.

In the ordinary myxie, as we have seen, the swarm spores effect a true fusion and build up one mass of protoplasm. In the Acrasieæ, on the contrary, the swarm spores do not fuse or coalesce together, but only aggregate together, retaining a power of separating from and moving on one another. This is the first and broadest division of the group of organisms.

The next characteristic which has been used for the classification of the group is the position of the spores in the organism. Hitherto we have only mentioned spores as contained within the sporangium; but there are one or perhaps two species very different in many ways from the rest of the group, in which the spores are carried on the outside of the organism. From this character the whole myxomycetes have been divided into two classes: the Exosporeæ, in which the spores are developed on the outside of the *sporophore—i.e.*, the part of the organism which bears the spores; and the Endosporeæ, in which the spores are generated within the sporangium.

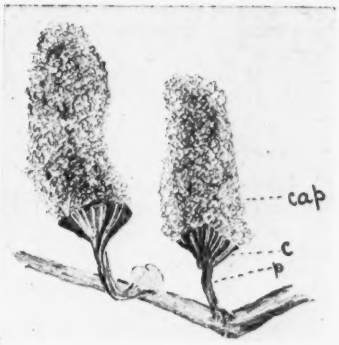


FIG. 6.—*Arcyria punicea* (*cap* = *capillitium*; *c* = *cup*; *p* = *pedicel*) × about ten diameters.

(*a*) NOTE.—To avoid confusion, it may be well to state that in the foregoing table we have followed the classification of De Bary—that Van Tieghem would write "Myxomycetes" as the name of the whole class where we have written "Mycetozoa," and would write "Myxomycetes proprement dits" where we simply write "Myxomycetes"; and that Mr. Lister uses "Mycetozoa" for what we have called "Myxomycetes," and so excludes the *Acrasieæ* from the Mycetozoa.

We propose hereafter to consider somewhat more in detail the peculiarities of these two sets of aberrant forms; but they will be better appreciated after we have dealt with the larger group. We therefore now turn to the myxies which carry their spores within the sporangium, and we shall indicate some of the points of structure of which use has been made for the purposes of classification.

Fructification.—Perhaps the point of distinction which first arrests the eye of the student is the variety of form in which these organisms fructify and bear their spores.

These forms, to which different designations have been given, may be considered:—

α. The sporangium, a term which is sometimes applied to the spore-bearing organ in general, has been often applied in a narrower sense when that organ is well defined

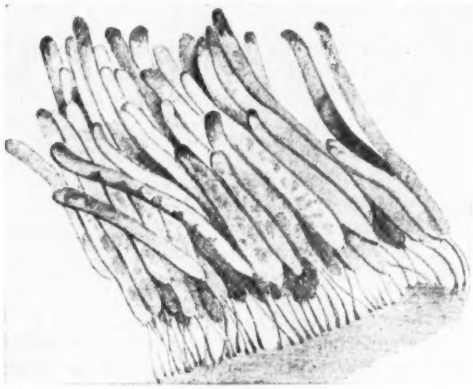


Fig. 7.—*Stemonitis ferruginea*. Group of sporangia. × about eight diameters.

and symmetrical, such as the grape-like structures of *Badhamia* (Fig. 1), the baskets of *Cribraria* (Fig. 5), or the elongated forms of *Arcyria* or *Stemonitis* (Figs. 6 and 7).

β. Plasmodiocarp is a term applied to the spore-bearing part when it is sessile and irregular in form, sometimes like a cushion, sometimes like a creeping snake or a long tube. It may be said to represent the aggregated plasmodium which has stayed its onward course, gathered itself together, covered itself with a coat, and then produced spores. This form is shown at *a*, in Fig. 8.

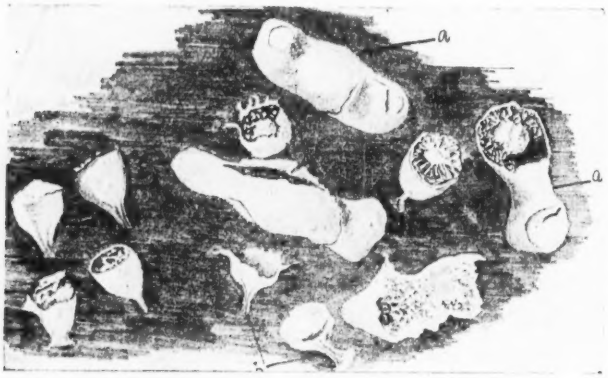


Fig. 8.—*Craterium pedunculatum*. Group of Sporangia and Plasmodiocarps. × about 10 diameters.

γ. Æthalium is the name given to that form of fructification in which a number of separate spore cases exist; but where they are so densely packed together, so intricately coiled, and so freely anastomosing that their individuality seems to disappear. The *Fuligo septica*, the myxie to which we have already often alluded as living on tan, and which is known as the flowers of tan (the only instance, we believe, in which any one of these organisms has the slightest claim to an English name), is an instance of this form of fructification. Fig. 9 exhibits a section of the mature æthalium of Fuligo.

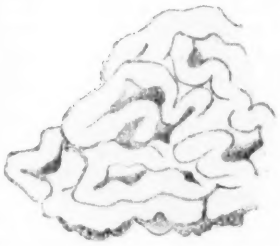


Fig. 9.—*Fuligo septica*. Section of mature æthalium. Somewhat enlarged.

Though it is both possible and convenient thus to classify the forms assumed by the fructification, it must not be supposed that the lines between them are hard and fast; on the contrary, there are abundant instances in which the plasmodiocarp and sporangium forms merge into one another; frequently the two forms will co-exist as the products of one and the same plasmodium.

Thus the beautiful little cups of *Craterium* will sometimes fail of complete separation, and part of the plasmodium is content to take the cruder form of a plasmodiocarp, as shown in Fig. 8. Again, sporangia, which are sometimes stalked, are at other times sessile, and thus differ but little from a plasmodiocarp. In the *Dictyostelium* (one of the Acrasieæ to be hereafter mentioned), a similar phenomenon has been observed; although in the normal form the production of spores occurs at the top of the pedicel, or column, in some cases the plasmodium turns into spores without ever developing the column at all.

There appears to be a considerable difference in the way in which the plasmodium turns into sporangia. In some cases the plasmodium first separates, and then each separate part forms a sporangium. In other cases the plasmodium begins its transformation as a whole, and breaks up into sporangia as the process advances.

Comatricha and *Craterium* appear to be cases of the former mode of procedure; *Stemonitis* of the second. Thus in *Comatricha* the plasmodium emerges in separate centres, like small conical hillocks on the wood. These grow upward, and as they approach maturity the upper part of the protoplasm draws all the lower part after it, except so much as goes to form the pedicel and *hypothallus*, or foot.

Fig. 10.—*Stemonitis fusca*. Plasmodium turning into Sporangia. (After De Bary.) Enlarged.

In *Stemonitis*, on the contrary, the plasmodium gathers itself together in a lump or mass, and first shows signs of dividing up by the appearance of papillæ on the surface; then at points corresponding with the papillæ, dark-coloured stems grow upwards in the gelatinous mass. Around these stems, portions of the adjoining protoplasm gather, and separate vertically from their neighbouring parts; and again, before maturity, the lower portion of the protoplasm around each column moves upwards, leaving only the delicate stalk which supports the arborescent sporangium. Fig. 10 will explain these steps in development.

It would seem as if the sporangium forms were the most highly developed, and the plasmodiocarp form the more rudimentary. We suppose that in the matter of advantage to the organism there must be something to be said for and against each form, for the plasmodiocarp must expend less material on perishable walls and stalks, and, on the other hand, be less open to the atmospheric influences; whereas the opposite in each respect must apply to sporangia. If one of these forms be better than the other, why does it not universally prevail? and why do some individuals of some species halt between the two opinions? We certainly do not know. This is one of the many cases in which it is at least very difficult to see any advantage gained by the variations of development of an organism.

Sporangium Walls.—The walls of the sporangium vary very greatly; sometimes they consist of a single membrane; sometimes of two or even three membranes; sometimes they continue till by rupture they let loose the spores; in other cases, the whole, or the upper part only, early falls away and discloses the system of hairs and the spores within; sometimes, as we shall see, they are furnished with lime, at other times they are without it.

In *Cribraria* (Fig. 5) we have a very beautiful form of sporangium, the wall of the lower half persists and forms a cup, whilst the upper half in its mature state consists of a network only of slender threads more or less thickened at the points where they cross one another.

In *Dictydium* we have again another very beautiful form of sporangium—it consists of rays of longitude gathered together at the pedicel and at the top as their two poles, with much slighter transverse lines of latitude. The intervening membrane falls away in whole or in part, and leaves for the sporangium a basket of most delicate network (*see* Fig. 11).

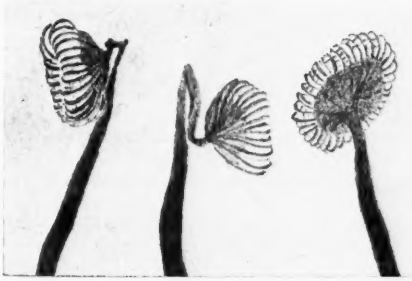


Fig. 11.—*Dictydium umbilicatum.* Empty Sporangia. × about 40 diameters.

In some cases the exterior of the sporangium has a most delicate surface, shining with iridescent colours. The *Lamproderma* is a genus with several species distinguished by this beautiful peculiarity. Our English species are very attractive, but they are excelled in brilliance by some tropical kinds. Of other genera, the *Physarum psittacinum* is another species with iridescent sporangia, and derives its name from its supposed resemblance to the colours of a parrot.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Swift's Comet (1899a).—This comet promises to be an interesting object for the telescope during May. Its approximate positions will be as follow :—

1899.	R.A. h.	m.	Dec.	Brightness.	Distance from Sun.
May 1	0	9	+ 22° 33′	1·8	35°
„ 6	23	50	+ 27° 19′	1·7	44°
„ 11	23	26	+ 33° 13′	1·7	53°
„ 16	22	53	+ 40° 28′	1·7	63°
„ 21	21	58	+ 48° 45′	1·8	75°
„ 26	20	27	+ 55° 48′	1·7	87°
„ 31	18	22	+ 56° 56′	1·5	98°
June 5	16	40	+ 51° 10′	1·2	106°
„ 10	15	39	+ 43° 2′	0·8	112°

On May 1st the comet will be nearly twice as bright as when discovered, so that it ought to be well visible to the naked eye. It will rise about three hours before the Sun, and will be placed six degrees S.S.E. from α Andromedæ. Moving rapidly to N.W., it will pass one and a-half degrees S. of o Andromedæ on May 16th, and on June 1st may be seen in the head of Draco, close to ξ. On June 16th the comet will be much fainter and a few degrees west of δ Herculis. Between about the middle of May and June 12th, it will be visible all night, as it will be placed within the circle of perpetual apparition.

Tuttle's Comet.—This comet may possibly be observed after sunset in the N.W. region of Orion, but the strong twilight will render it extremely faint.

Holmes's Comet (1892 III.) is now gradually approaching the earth, but its position in May will be such that it can only be observed a short time before sunrise. In later months it will be presented under more favourable conditions, as it is moving northwards. The re-discovery of this singular comet is awaited with special interest.

Tempel's Comet (1873 II.) is also expected, and will be favourably situated in the morning sky during ensuing months. On May 1st its position will be in R.A. 281°, Dec. 5° south, and close to the star 6 Aquilæ (magnitude 4½). The comet is travelling slowly to the east, and its brightness increasing.

Fireballs of March 1st.—In our notes for last month some details were given of two fireballs recorded at 7h. 1m. and 8h. 50m. on this date. The path of the former, as observed by Mr. Astbury at Wallingford, Berks, was from 340° + 63° to 323° + 44°, which it traversed in two-and a-half seconds, and the brilliancy of the object near the close of its visible career greatly exceeded that of Sirius. The meteor was seen by Sir W. J. Herschel, at Littlemore, near Oxford, and he describes it as the most brilliant which he had ever observed. The apparent path was from about seven degrees preceding β Cassiopeiæ, and descending almost vertically to within ten degrees of the horizon. Duration two-and-a-half seconds. Light about four times that of Venus. The same object was noticed by the Rev. A. T. Fryer, of Cardiff, while walking between Bridgend and Tondu, and his observation is described in the *Cambrian Natural Observer* for March, 1899. He says the meteor descended in a curve, roughly parallel with and to the north of the tail of Ursa Major. The colour was very remarkable—very light blue on the body but ending in brilliant red of a deep tone, like the red which the winter sun shows in setting. The meteor was fish shape.

From the above observations I have endeavoured to compute the real path. The meteor was a fine Geminid, and evidently belonged to the same system as that which supplied the fireball at about 8h. 50m. on the same night. The former was probably first seen when at a height of seventy miles over Stourbridge, and disappeared over a point five miles S.S.W. from Shrewsbury at a height of twenty-five miles. Its length of path was about fifty-five miles, and velocity twenty-two miles per second. This differs materially from the ten miles per second found for the fireball seen at a later hour, and it is probable that a mean of the two values—about sixteen miles per second—would more correctly represent the actual motion. The two fireballs are interesting as proving that the Geminid radiant continues active until the beginning of March.

XUM

Fireball of April 4th.—On April 4th, at 7h. 59m., Mr. C. Parker, of Handsworth, Birmingham, saw a brilliant meteor. It started from η Ursæ Majoris, and finished its course one degree beyond β Cassiopeiæ. When near the latter star, it broke up into three pieces. The meteor was brighter than Jupiter, and exhibited a marked variation in colour during its flight. The same object was observed by the Rev. R. Killip, of St. Anne's on-Sea, Lancaster, and he gives some details in *The English Mechanic* (April 14th). The time was 7h. 56·5m., and the meteor was estimated as fully twice as bright as Venus. It was first observed near α Cassiopeiæ, and travelled leisurely towards ϕ Andromedæ, dying out when eight or ten degrees from the W.N.W. horizon. This fireball appears to have been directed from a well-known April radiant of large meteors at about 205°–9° in Libra: but the above two observations appear to be somewhat discordant, and a satisfactory real path of the object cannot be computed from them.

Fireball Epochs.—There are many well-known fireball epochs during the year, and it is intended to make special observations with a view to discover the principal showers to which they belong. It is certain that at some of these periods a large number of streams are displayed, and that the paths of such fireballs as have been observed will not conform with any one radiant. They have exhibited considerable variety in their directions of flight, but it is hoped that further observation will reveal many of the chief systems of fireballs.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

The respiratory system, and other organs of many insects, may be clearly shown by bleaching with peroxide of hydrogen.

A saturated solution of neutral red in 0·8 per cent. sodium chloride is recommended for demonstrating the hæmoglobigenous granules in the erythrocytes of certain animals, such as the lamprey, frog, guinea-pig, and fowl embryos.

A solution consisting of pure glycerine and three per cent. formalin, in the proportion of three parts of the former to two parts of the latter, has been suggested as an effective preservative for fresh-water sponges. Unlike alcohol, it does not decolourize the specimens.

One of the principal difficulties hitherto experienced in the use of the electric arc lamp for microscopical purposes has been that of keeping the position of the arc constant and of securing a sufficiently small and uniform source of light. At a recent meeting of the Quekett Club, Mr. J. E. Barnard gave an account of the improvements he had made in this direction, whereby he had adapted an electric arc lamp for micrographic and photo-micrographic purposes. He regulates both the position of the carbons and the distance between the carbon points by hand in such a way, that, by reference to cross wires on a glass screen, the source of light can always be kept in the same place, while "the oblique position in which the carbons were set enabled the small point of intense light from the incandescent crater of the positive carbon to be used as a source of unvarying and steady illumination of small area but very great intensity." This steadiness and intensity render the light specially suitable for photographing with high power objectives.

The last issue of the *Transactions of the South-Eastern Union of Scientific Societies*, contains *inter alia* a suggestive paper by Mr. E. M. Holmes, F.L.S., entitled "Botanical Work wanting Workers." The author refers briefly to work that may be done among the mosses, scale mosses, fungi, lichens, marine algæ and freshwater algæ, and indicates lines of work that might be followed and the localities in south-eastern England where the best results are likely to be obtained. He appeals specially to microscopists to take up the life-history of algæ, both fresh-water and marine, but particularly the latter. Little is known of the changes that take place between the times when these plants disappear and reappear again; and it is not even known whether some of the algæ are not merely stages of growth of others. This is especially true of those plants in which only vegetative growth and reproduction are known, and in which sexual reproduction is unknown. It is suggested that the systematic observation during cultivation of such plants as Porphyridium, Chroococcus, Oscillaria, Tetraspora, and Schirogonium, might add considerably to our knowledge of their life-histories.

Students of marine algæ are likewise appealed to. We know very little of the life-cycles of the common Laminariæ. Mr. Holmes therefore suggests a careful study of these by cultivation from their spores. A microscopical examination once a fortnight throughout the year might result in finding the cystocarps of *Rhodymenia palmata*, the unknown tetraspores of some of the species of *Phyllophora*, *Ahnfeltia plicata*, and of *Gigartina mamillosa*, as well as the fructification of *Sphacelaria scoparia*, which, so far as is known, has never been found in this country. The paper is as practical as it is suggestive, and it is well worth the consideration of those who are desirous of taking up a line of research.

The following useful piece of apparatus for carrying material through the processes of fixing and hardening has been devised by Mr. W. C. Stevens, of Kansas University. It is specially suitable for very small objects, such as root-tips, sporanges, and young flower buds. Small glass buckets are made by cutting up glass tubing one centimetre in diameter into lengths of three centimetres. By means of heat, one end of each piece is turned out so as to form a rim; over this a piece of muslin is tied. The little bucket is provided with a suspender by means of a piece of thread fixed in the middle of the bottom; and the specimen is then placed in the bucket and suspended in the fixative fluid.

To obtain the most satisfactory definition with high power objectives, "critical" illumination is a *sine quâ non*. The microscope should be placed in a horizontal position, with its mirror turned on one side, and the lamp and microscope should be so arranged that the thin edge of the flame shall be projected along the optical axis of the condenser, and so that its image, when viewed with a one-inch objective shall be sharply defined in the same field of view as that occupied by the objects when under observation. The substitution of the one inch objective for either a $\frac{1}{19}$th, $\frac{1}{25}$th, or a $\frac{1}{50}$th, may now be made, and, after a slight readjustment of the achromatic condenser, it will be found that, the field of view will be so brilliantly illuminated, the most minute flagellate organisms are defined with an amount of sharpness rarely obtained under any other conditions.

Of late years considerable progress has been made in the methods adopted for the determination of the structural characteristics of steel by means of the microscope. In a paper, read before the American Microscopical Society, Mr. F. S. Rice briefly reviews the present state of our knowledge of the subject, and gives some very interesting details regarding the preparation and mode of examination of specimens. His experience has shown that specimens three-fourths of an inch in diameter, and mounted on ordinary slips, are the most convenient. He deprecates the use of emery and crocus papers, rouges, and wheels charged with polishing and cutting compounds, but suggests instead, that the best sections are obtained by carefully grinding off the surface to a plane, by hand, on an ordinary quick-cutting oil-stone, then on the finest Belgian oil-hone, and, finally, polishing on a piece of chamois leather tightly stretched over a block of wood charged with peroxide of tin. The specimen is finished by washing thoroughly with alcohol, followed by a little chloroform.

Professor E. Mead Wilcox, of Harvard University, advocates in the columns of the *Journal of Applied Microscopy* the use of soap for imbedding plant tissues. It is frequently found that it is not practicable to apply either the paraffin or the collodion methods on account of the time that they require. Fleming, Lee, and Pfitzer have each suggested the soap method, and have practised it at different times with more or less success. Prof. Wilcox now gives his experiences in this direction. He finds that glycerine and alcohol together as the solvent give the best results. A tablet of Pear's soap was cut into small pieces and dissolved in a mixture of equal parts of ninety-five per cent. alcohol and glycerine. The resulting liquid was then poured into a warm, shallow dish and allowed to harden, after which it was ready for use. Before imbedding the tissues it has been found desirable to immerse them in a diluted solution of the soap, in order that thorough penetration or infiltration may be secured. Final imbedding may then be accomplished in a watch glass.

THE FACE OF THE SKY FOR MAY.

By A. FOWLER, F.R.A.S.

THE SUN.—The Sun rises on the **1st** at 4.33, and sets at 7.21; on the **31st** he rises at 3.51, and sets at 8.3. A fine group of spots was visible during the latter part of March, so that the Sun may still be worth careful scrutiny.

THE MOON.—The Moon will enter her last quarter on the **2nd** at 5.47 P.M.; will be new on the **9th**, at 5.39 P.M.; enter her first quarter on the **17th**, at 5.13 P.M.; will be full on the **25th**, at 5.49 A.M.; and enters her last quarter on the **31st** at 10.55 P.M.

On the **24th**, there will be an occultation of B.A.C., 5254, magnitude 5·4. Disappearance at 10.15 P.M., at 125° from north point (138° from vertex); reappearance at 11.25 at 261° from north point (264° from vertex).

On the **26th**, 7 Sagittarii (magnitude 5·4) will be occulted. Disappearance at 11.39, at 51° from north point (69° from vertex); reappearance at 0.39 at 302° from north point (312° from vertex).

THE PLANETS.—Mercury is a morning star, reaching his greatest westerly elongation of 26° 4′ on the **10th** at 4 A.M. He rises, however, only about half-an-hour before the Sun, so that he will not be seen with the naked eye in our latitudes.

Venus is a morning star, but, like Mercury, does not rise early enough to be seen with the naked eye. On the **12th** she rises at 3.22 A.M., that is 53m. before the Sun, and crosses the meridian at 9.51 A.M.

Mars remains visible throughout the month, but as his apparent diameter is only 6·6″ at the beginning of the month and 5·6″ at the end, he is not very accessible to small telescopes. Still, about the end of March, when the apparent diameter was not more than 8·8″, the principal markings were readily perceived. He is a little east of the Praesepe, in Cancer, at the beginning of the month, and afterwards travels almost directly towards Regulus. On the **1st** he sets at 2 A.M., and on the **31st** at midnight. Nine-tenths of the disc will be illuminated.

Jupiter is a conspicuous object, though not far above the horizon. During the month he describes a westerly path, lying roughly midway between Spica and α Libræ. He will be due south at 11.32 P.M. on the **1st**, and at 9.22 P.M. on the **31st**, his altitude on the meridian at London being about 27°. The eclipse disappearances and reappearances take place on the eastern side of the planet; in the case of the first satellite (Io), only the reappearances are visible. The satellite phenomena are especially interesting at convenient hours on the **6th**, **7th**, **13th**, **14th**, **15th**, **22nd**, **23rd**, **29th**, **30th** and **31st**.

Saturn is a little more favourably placed for observation than last month. On the **1st** he rises at 10.48, crossing the meridian at 2.51 A.M., and on the **31st** at 8.40, crossing the meridian at 12.45. He is still in the southerly part of Ophiuchus, and traverses a short westerly path. When on the meridian at London, his altitude is only 16°. At the middle of the month the polar diameter of the planet is 16·8″; the major and minor axis of the outer part of the ring are respectively 42·2″ and 18·9″; the major and minor axis of the inner edge of the bright ring are respectively 26·8″ and 12·0″. It will be seen that the rings are very widely open. The northern surface of the rings is visible.

Uranus is in opposition on the **27th**. He is nearly 5° north of Antares, but with his south declination of 21½°, he only reaches an altitude of 17° when on the meridian at London. He rises on the **1st** at 9.36, and on the **31st** at 7.32, crossing the meridian on these dates at 1.46 A.M. and 11.39 P.M. respectively. His apparent diameter is 3·7″.

Neptune is practically not observable.

THE STARS.—About 10 P.M. at the middle of the month, Spica Virginis will be due south, Arcturus a little east of south, Ursa Major nearly overhead, Scorpio rising in the south-east, Vega pretty high up in the east, Cygnus north-east, Leo in the south-west, and Gemini a little north of west.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of April Problems.

No. 1.

1. K to K2, and 2. Q to Q2, etc.

No. 2.

1. B to R8, and 2. K to Kt7, etc.

[Other variations obvious.]

CORRECT SOLUTIONS of both problems received from Alpha, K. W., J. T. Blakemore, Capt. Forde, A. H. Doubleday, J. H. Jones, F. V. Louis, C. S. Kershaw J. M. K. Lupton, J. Herbert.

Of No. 1 only, from R. Inwards, W. de P. Crousaz, G. J. Newbegin, Gerald Todd, J. Baddeley.

W. de P. Crousaz.—After 1. R to Kt5ch, K to R2; 2. B to R8, Black need not take the Bishop. If two *keys* to a sound problem are received, the solution counts as incorrect. A *reductio ad absurdum* would show the necessity for this. In the case of duals on the second move it is different. We no longer have your card, but fancy that you sent more than one key to No. 2 (March).

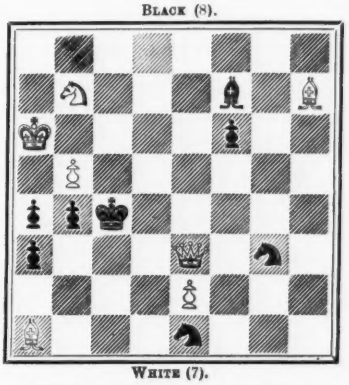
J. T. Blakemore.—Thanks for your contribution, which we publish with pleasure. Have you an original problem for publication?

PROBLEMS.

No. 1.

By H. Bristow.

BLACK (8).



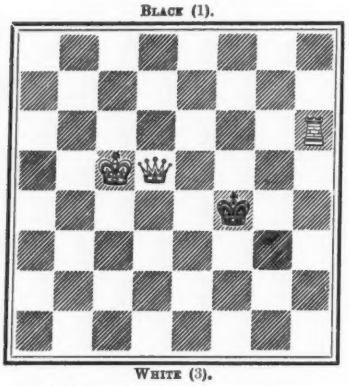
WHITE (7).

White mates in two moves.

No. 2.

By T. Hane (Prague).

Black (1).



White (3).

White mates in three moves.

CHESS INTELLIGENCE.

The Inter-University match was played at the British Chess Club, on the 24th ult., the Cambridge representatives winning easily with a score of $5\frac{1}{2}$ to $1\frac{1}{2}$. Some such result might have been expected from a casual review of the score made by the combined teams in their trial matches against the principal London clubs earlier in the week. In these matches the Cambridge men invariably contributed considerably more than half the combined score. Cambridge are now eight matches to the good. The score was as under :—

Cambridge.		Oxford.	
C. E. C. Tattersall	1	A. H. W. George	0
L. MacLean	1	A. P. Lacy-Hulbert	0
H. G. Softlaw	1	G. E. H. Ellis	0
A. Fotheringham	1	F. Soddy	0
R. S. Mackower	$\frac{1}{2}$	F. A. Babcock	$\frac{1}{2}$
J. E. Wright	0	H. Hilton	1
C. C. Wiles	1	L. Giles	0
Total	$5\frac{1}{2}$	Total	$1\frac{1}{2}$

The combined Universities lost all four of the matches earlier in the week against very strong opponents. Against Hastings they scored $5\frac{1}{2}$ to $8\frac{1}{2}$, against the Metropolitan Club $7\frac{1}{2}$ to $10\frac{1}{2}$, against the British Chess Club 6 to 15, and against the City of London Club 8 to 14. Messrs. Tattersall and MacLean made very fine scores in all those matches, and are undoubtedly the two best players out of the fourteen.

Yorkshire defeated Lancashire on the day of the cable match by 20 games to 11. Mr. Burn elected to represent Lancashire in this match, rather than assist the British Isles against the United States.

Messrs. P. Howell, T. F. Lawrence, and L. Zangwill tied for second prize in the City of London Tournament, won by Mr. Jacobs, as stated last month; Messrs. F. Leye and R. Loman were bracketed fifth. The handicap was won by Mr. E. O. Jones.

Mr. Mills has once more won the Scottish Championship. We fancy that he has never failed to accomplish this feat.

Messrs. Janowski and Showalter are engaged in a return match, the American native leading at present by $3\frac{1}{2}$ games to $2\frac{1}{2}$, a considerable improvement on his score in the first match, which he lost by seven games to two. The negotiations for a match between Janowski and Pillsbury have fallen through, at any rate until after the London International Tournament, which begins on May 30th.

A Midland Counties Chess Tournament was held at Birmingham during Easter week. The competitors, and the order of the prize-winners, remind one of the January Craigside Tourney. Mr. Burn took the first prize, Mr. Atkins the second, Messrs. Bellingham and Sherrard coming next.

The Annual Chess Festival at Hastings took place towards the end of March. In the consultation games, Messrs. Blackburne and Chapman (an invincible combination) defeated Messrs. Teichmann and Trenchard; Messrs. Teichmann and Bullock beat Mr. Gunsberg and Dr. Colborne, while Messrs. Gunsberg and Guest drew against Messrs. Blackburne and Jenour. Mr. Gunsberg's simultaneous performance resulted in fourteen wins, three draws, and four losses to the single player. Mr. Blackburne, playing six games blindfold, won four and drew the other two. The interesting performance in which each master plays two simultaneous games against two sets of consultants, resulted in Mr. Teichmann's winning both his games; Mr. Blackburne won one and drew the other, while Mr. Gunsberg drew one and lost one. The Championship of Sussex final round was played for at this meeting, and resulted in the victory of Mr. D. B. Kitchin. Mr. Shoosmith, last year's champion, did not compete.

KNOWLEDGE, PUBLISHED MONTHLY.

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